Teaching Generative Language

Workshop Resources

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Resources: Procedures and Data Sheets

Teaching Protocol: Increasing Flexibility of Contextual Control in Relations of Coordination
(Tact + Intraverbal Responding)

Goal: Student will be able to respond in accordance with varying contextual cues when tacting common objects and their features or functions.

When to introduce:
- Student is able to tact objects by name, tact color, tact shapes, tact the function of objects, and tact the parts of objects, when questions are presented in isolation.
- Student is not able to tact name, color, shape, function, or part when questions are provided randomly as to which aspect of the item is to be tacted, and/or with novel items
  - Fails VB-MAPP Tact M11

Materials:
1. Multiple sets of items which have varied colors (e.g. Playdoh cut-outs so that the "duck" could be yellow or blue, etc.)
2. Multiple sets of items that have obvious (and varied if possible) shapes and varied colors (e.g. boxes, valentine hearts, balls, plates)
3. Multiple sets of items that have obvious parts and varied colors (e.g. stuffed animals, toy cars)
4. Multiple sets of items that have obvious functions and varied colors (e.g. crayons/markers, plates, cups)

Procedure:

1: Name vs Color
- With an array of items, state, "We're going to play a game, the name/color game. I'm going to point to one of these things. When I say "name" you tell me its name. When I say "color" you tell me the color."
- Tell the student "let's do "name" first," and then present a block of trials pointing to items and stating "name" until the student is able to respond correctly for 5 consecutive trials.
- Tell the student "now let's do "color" and then present a block of trials pointing to items and stating "name" until the student is able to respond correctly for 5 consecutive trials.
- When the student is able to switch immediately between name and color given the above cues, say, "Now I'm going to mix it up, listen carefully…" and present blocks of either name or color, switching when the student responds correctly for 3 consecutive trials. When the student can respond correctly for 8/10 trials, begin to randomize the presentation of either "name" or "color". When the student can respond correctly for 3 consecutive switched trials (i.e. when the previous trial was "name", responds correctly to color or vice versa), test for generalization with a new set of items.
- Once the student is able to respond consistently to "name" or "color" cues with novel items,
  a) Using the same structured teaching format, start varying and expanding the verbal instruction, such as "what's its name?" vs "what color is it?"

b) Using the single word cues "name" or "color", present trials for items in the natural environment, walking around and playing the name/color game.

2: Name vs Shape vs Color

- Introduce once name vs. color is consistent in structured teaching with single-word cues.
- Using the same teaching sequence as above, teach responses to the cues of name vs shape, shape vs color, and then all three.

3: Name vs Part vs Color

- Introduce once name vs. shape vs color is consistent in structured teaching with single-word cues.
- Using the same teaching sequence as above, teach responses to the cues of name vs part, part vs color, and then all three.

4: Name vs Function vs Color

- Introduce once name vs. part vs color is consistent in structured teaching with single-word cues.
- Using the same teaching sequence as above, teach responses to the cues of name vs do, do vs color, and then all three.

Criterion: Three consecutive first trial cold probes with the student correctly tacting in accordance with the contextual cue when the cue has switched, with novel items.

Matrix Data Sheet

Verbs / Nouns									
	Date Intro: Date Acquired:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:	Probe: Y N Date:
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Assessing DRR: The Training and Assessment of Relational Precursors and Abilities

SAME

TARPA: Structure

Track
Directly Trained Level
Tested Level
Directly Trained Section
Maintenance Section
Tested Section
Relational Training Section

Stage 1: Basic Discrimination
- **Track: Visual**
  - Section 1: Blank vs Visual
  - Section 2: 2 Visual Comparisons
  - Section 3: 3 Visual Comparisons
- **Track: Auditory**
  - Section 1: Blank vs Auditory
  - Section 2: 2 Auditory Comparisons
  - Section 3: 3 Auditory Comparisons

Stage 2: Conditional Discrimination (Formally SIMILAR Stimuli)
- **Track: Visual**
  - Section 1: 2 Visual Comparisons
  - Section 2: 3 Visual Comparisons
  - Section 3: 3 Visual Identity Matching
- **Track: Auditory**
  - Section 1: 2 Auditory Comparisons
  - Section 2: 3 Auditory Comparisons
  - Section 3: 3 Auditory Identity Matching

Stage 3: Conditional Discrimination (Formally DISSIMILAR Stimuli)
- **For Each Track:**
  - Level 1: Conditional Discrimination
  - Level 2: Mutual Entailment
    - Section 1: Training A→B
    - Section 2: Maintenance A→B
    - Section 3: Testing ME B→A
    - Section 3t: Training ME B→A
    - Section 4: Training C→B
    - Section 5: Maintenance C→B
    - Section 6: Testing ME C→B
    - Section 6t: Training ME C→B
  - Level 3: Combinatorial Entailment
    - Section 1: Training A→B
    - Section 2: Maintenance A→B
    - Section 3: Training C→B
    - Section 4: Maintenance C→B
    - Section 5: Training Mixed A→B, C→B
    - Section 6: Maintenance Mixed A→B, C→B
    - Section 7: Testing CE A→C/C→A
    - Section 7t: Training CE A→C/C→A
    - Section 7ti: Training CE A→C
  - Level 4: Transformation of Function
    - Section 0: CE Maintenance
    - Section 1: Training Function
    - Section 2: Testing Transfer
    - Section 2t: Training Transfer

Assessing Early Derived Relational Responding

Background:

This protocol assesses the emergence of untrained relations across three different verbal operants, as well as with arbitrarily related visual stimuli within a familiar context:

- Teach tact, derive listener (mutual entailment), derive intraverbal (combinatorial entailment)
- Teach listener, derive tact (mutual entailment), derive intraverbal (combinatorial entailment)
- Teach intraverbal, derive intraverbal reversal (mutual entailment), derive intraverbal (combinatorial entailment)
- Teach two visual-visual associations, derive a third

The protocol may also be used to determine how quickly a student can learn brand new conditional discriminations (i.e., trials to criterion) for each of the three operants and arbitrary visual association matches.

All assessment with verbal operants is done in the context of learning the "names" of different "pet" animals of various common types. Students should be able to tact and discriminate as a listener any animals used as assessment stimuli, and should be able to identify the sounds the animals make with LRFFC, TFFC, and intraverbal trials. Assessment with arbitrary visual relations is done in the context of animals who live in particular places and like particular foods.

All assessment is done with stimulus "sets" designated A1-B1-C1/A2-B2-C2. For all the verbal operant assessments, A is the animal's "name" (i.e. pet name—Bob, Sue, etc.), B is the animal itself (picture, or in the case of intraverbal training, the name, such as lion), and C is the sound the animal makes, in the following arrangements:

- Teach tact/derive listener/derive intraverbal
- Teach listener/derive tact/derive intraverbal
- Teach intraverbal/derive intraverbal reversal/derive intraverbal

For visual association assessment, A is the place picture, B is the animal picture, and C is the food picture.

Procedures: Training and testing

<u>**Training**</u>: All training should proceed using standard discrete trials and correction procedures, or as has been identified as appropriate and effective for the student. Reinforcement should be provided on the schedule that has been identified as effective for the student, and other mastered trials may be interspersed to maintain success and motivation as needed. ***However:*** in this case, in contrast to what might be done during other types of training sessions, the teacher must be careful never to train the skill that is going to be tested, such as by inadvertently giving specific feedback, expansion, or other narration relevant to the task during reinforcement. The easiest way to ensure this is to follow the instructional script carefully for the presentation of SDs, and to only use general praise during reinforcement (e.g., great job! Way to go! Etc.). When

providing correction, wait for a short delay after the response before re-presenting the trial with a prompt.

__Testing__: During testing, no specific contingent reinforcement or feedback may be provided. Noncontingent reinforcement may be used to maintain motivation and attending to task. Reinforcement, if needed, is best provided after a delay from the target response (e.g., while setting up the next trial, with praise such as “you’re working so hard”), or by interspersing other mastered trials during the test and providing reinforcement for those responses.

Protocol: Teach tact/derive listener (mutual entailment)

Introduction: explain that you have some pets and you are going to teach the student the names of your pets.

Step 1: Teach the tact (A-B)
Step 2: Ensure tact is maintained without continuous reinforcement
Step 3: Test the listener response (B-A)

Protocol: Teach tacts/derive intraverbals (combinatorial entailment)

Once the student has demonstrated mutual entailment with the name of a pet, go on to test combinatorial entailment as follows:

Step 4: Review the newly learned and previously known tacts (A-B, C-B)
Step 5: Ensure the tacts are maintained without continuous reinforcement
Step 6: Test the intraverbal response (A-C/C-A)

Protocol: Teach listener response/derive tact (mutual entailment)

Introduction: explain that you have some pets and you are going to teach the student the names of your pets.

Step 1: Teach the listener response (A-B)
Step 2: Ensure tact is maintained without continuous reinforcement
Step 3: Test the tact response (B-A)

Protocol: Teach listener responses/derive intraverbals (combinatorial entailment)

Once the student has demonstrated mutual entailment with the name of a pet, go on to test combinatorial entailment as follows:

Step 4: Review the newly learned and previously known listener responses (A-B, C-B)
Step 5: Ensure the listener responses are maintained without continuous reinforcement
Step 6: Test the intraverbal response (A-C/C-A)

Protocol: Teach intraverbal/derive intraverbal (mutual entailment)

Introduction: explain that you have some pets and you are going to teach the student the names of your pets.

Step 1: Teach the intraverbal (A-B)
Step 2: Ensure intraverbal is maintained without continuous reinforcement
Step 3: Test the reverse intraverbal response (B-A)

Protocol: Teach tacts/derive intraverbals (combinatorial entailment)

Once the student has demonstrated mutual entailment with the name of a pet, go on to test combinatorial entailment as follows:

Step 4: Review the newly learned and previously known intraverbals (A-B, C-B)
Step 5: Ensure the trained intraverbals are maintained without continuous reinforcement
Step 6: Test the emergent intraverbal response (A-C/C-A)

Protocol: Teach visual association/test derived association (mutual entailment)

Step 1: Teach the first visual association, A-B (e.g., the cat lives in the house, the dog lives in the apartment building—given the house picture, "who lives here?"—match the cat, rather than the dog, to the house).
Step 2: Ensure the association is maintained without continuous reinforcement
Step 3: Test the reverse association, B-A (e.g., match the animal to the correct place, e.g. "where does the cat live?"—match the cat to the house rather than the apartment building)

Protocol: Teach visual association/test derived association (combinatorial entailment)

Step 4: Teach a new visual association, between the animal and the food they like, C-B (e.g. The cat likes ice cream, the dog likes hamburgers—match the animal to the correct food, e.g. "what does the cat like?")
Step 5: Make sure the previously learned and new relations are maintained: using the animals as the sample, rotate between matching to the place each lives in and the food each likes.
Step 6: Test the derived association, A-C/C-A: given the place, which food goes there?/given the food, where would you find it?

Stimulus Set :
A1 (name):
B1 (animal):
C1 (sound):

A2 (name):
B2 (animal):
C2 (sound):

Program: Assessing Early Derived Relational Responding

1. **Train Tact/Derived Listener Responding:**
   1.1. Train B→A What's his name [holding B]?: *criteria=6 consecutive correct across exemplars*
   1.2. Test A→B Which one is called [A]?: *criteria= 5/6 correct across exemplars*

Date	Train B1→A1								Train B2→A2								Test A1→B1:		Test A2→B2:	
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2. Combinatorial Entailment: **Derived Intraverbals**
   2.1. Review relations B→A What's his [B] name?, B→C What does he [B] say]? *criteria=12 consecutive correct across exemplars (3 per exemplar)*
   2.2. Check mixed maintenance B→A, B→C without specific feedback: *criteria=8/8 consecutive correct across exemplars*
   2.3. Test A→C (What does [A] say?) and C→A (Who says [C]?): *criteria= 7/8 correct across exemplars*

Date	Review B1→A1				Review B1→C1				Review B2→A2				Review B2→C2							
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Stimulus Set :
A1 (name):
B1 (animal):
C1 (sound):

A2 (name):
B2 (animal):
C2 (sound):

Program: Assessing Early Derived Relational Responding

1. **Train Listener Responding/Derived Tact:**
   1.1. Train A→B <u>Which one is called [A]?</u>: *criteria=6 consecutive correct across exemplars*
   1.2. Test B→A <u>What's his name [holding B]?</u>: *criteria= 5/6 correct across exemplars*

Date	Train A1→B1								Train A2→B2								Test B1→A1:		Test B2→A2:	
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2. Combinatorial Entailment: **Derived Intraverbals**
   2.1. Review relations A→B <u>Which one is called [A name]?</u>, C→B <u>Which one says [C]?</u> *criteria=12 consecutive correct across exemplars (3 per exemplar)*
   2.2. Check mixed maintenance A→B, C→B without specific feedback: *criteria=8/8 consecutive correct across exemplars*
   2.3. Test A→C (<u>What does [A] say?</u>) and C→A (<u>Who says [C]?</u>): *criteria= 7/8 correct across exemplars*

Date	Review A1→B1				Review C1→B1				Review A2→B2				Review C2→B2							
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Stimulus Set :
A1 (name):
B1 (animal):
C1 (sound):

A2 (name):
B2 (animal):
C2 (sound):

Program: Assessing Early Derived Relational Responding

1. **Train Intraverbal/Derived Reverse Intraverbal:**
    1.1. Train A→B <u>My pet named [A] is a [B]. What animal is my pet named [A]?</u>: *criteria=6 consecutive correct across exemplars*
    1.2. Test B→A <u>What is the name of my pet [B]</u>?: *criteria= 5/6 correct across exemplars*

Date	Train A1→B1								Train A2→B2								Test B1→A1:		Test B2→A2:	
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2. Combinatorial Entailment: **Derived Intraverbals**
    2.1. Review relations A→B <u>What animal is my pet named [A]?</u> /C→B <u>What kind of animal says [C]?</u> *criteria=12 consecutive correct across exemplars (3 per exemplar)*
    2.2. Check mixed maintenance A→B, C→B without specific feedback: *criteria=8/8 consecutive correct across exemplars*
    2.3. Test A→C (<u>What does my pet named [A] say?</u>) and C→A (<u>Which one of my pets says [C]?</u>): *criteria= 7/8 correct across exemplars*

Date	Review A1→B1				Review C1→B1				Review A2→B2				Review C2→B2							
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Stimulus Set :
A1 (place):
B1 (animal):
C1 (food):

A2 (place):
B2 (animal):
C2 (food):

Program: Assessing Early Derived Relational Responding

1. **Train/test visual association 1 (AB/BA):**
   1.1. Train A→B "Who lives here [holding A]?" : *criteria=6 consecutive correct across exemplars*
   1.2. Test B→A "Where does this one live [holding B]?": *criteria= 5/6 correct across exemplars*

Date	Train A1→B1								Train A2→B2								Test B1→A1:		Test B2→A2:	
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2. **Train/test visual association 2 (CB/BC):**
   2.1. Train C→B "Who likes this [holding C]?" : *criteria=6 consecutive correct across exemplars*
   2.2. Test B→C "What does this one like [holding B]?": *criteria= 5/6 correct across exemplars*

Date	Train A1→B1								Train A2→B2								Test B1→A1:		Test B2→A2:	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
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	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -		+ -	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					

Stimulus Set :
A1 (place):
B1 (animal):
C1 (food):

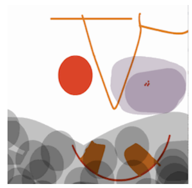
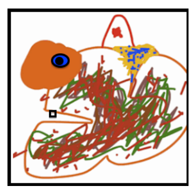
A2 (place):
B2 (animal):
C2 (food):

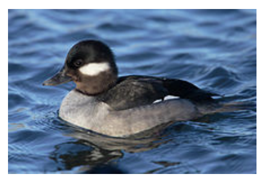
3. **Combinatorially Entailed Derived Visual Associations**
   3.1. Review relations A→B Who lives here [holding A]? C→B Who likes this [holding C].? *criteria=12 consecutive correct across exemplars (3 per exemplar)*
   3.2. Check mixed maintenance A→B, C→B without specific feedback: *criteria=8/8 consecutive correct across exemplars*
   3.3. Test A→C (What food would you find here [holding A]?) and C→A (Where would you find this [holding C]?): *criteria= 7/8 correct across exemplars*

Date	Review A1→B1				Review C1→B1				Review A2→B2				Review C2→B2							
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				

Date	Maint A1→B1				Maint C1→B1				Maint A2→B2				Maint C2→B2				Test AC1	Test AC2	Test CA1	Test CA2
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -

Data Collection Instructions: Fill in targets. Circle correct/incorrect each trial presentation; score right to left and top to bottom, drop down a row after an error is made and restart your count towards 6 consecutive correct responses using as many rows as needed. Do not score trials within a correction procedure. Fill in date for each teaching session on first row used for session. End session after either 6 cumulative errors, 25 trials total, reaching pass criteria for that step, or based on student motivation. At end of each teaching session highlight trials indicating pass criteria (if reached).

A (name)	B (pic)	C (sound)
Colored Abstract Stimulus Set 1		
Aps		boo
blanti		eep
Stimulus Set 2		
Blab		git
flarti		tlaw
Stimulus Set 3		
Specme		Woosh
Mro		Guff

Set: Real Life	A (name) (new)	B (animal) (known)	C (sound) (known)
Set 1	Jack		Roar
	Ted		Ssss
Set 2	Sue		Quack
	Jane		Moo
Set 3	Fred		Woof
	Joe		Meow

Assessing Early DRR Checklist

Stimulus Arrangements

- ✓ Stimuli are familiar and pronounceable for the child
- ✓ Stimuli are selected that do not have previous associations with each other, same letter starts, rhymes, etc.
- ✓ Stimuli are presented in random or quasi-random rotation (not mass trials)
- ✓ Visual stimuli are picked up and replaced in random positions for each trial

Data Collection

- ✓ Data form indicates which stimulus relations and specific SDs are being used on each trial
- ✓ Data are collected on a trial-by-trial basis, across all stimulus relations

Trial Presentation

- ✓ Vocal and/or visual stimuli presented are appropriate to the stimulus relation being trained or tested, as per assessment data sheet/script (e.g. no visual stimuli present if testing intraverbals; no use of intraverbal statements or additional associated verbal stimuli in tact trials, etc.)

Reinforcement in Directly Trained or Maintenance Trials

- ✓ Any additional reinforcement systems normally used for instruction with child are available and used on typical schedule
- ✓ Social praise provided
- ✓ Only general praise/feedback used, no specific statements regarding stimuli

Error Correction in Directly Trained or Maintenance Trials

- ✓ Demonstrate: appropriate verbal instruction and accurate demonstration
- ✓ Guide: appropriate verbal instruction and prompt
- ✓ Independent trial: appropriate verbal instruction and allow up to 5s to respond
- ✓ Error correction procedure repeated accurately one time if error made at independent trial

Reinforcement in Tested Trials

- ✓ No specific reinforcement used
- ✓ Any verbal statements are neutral, including prompts to continue responding
- ✓ Reinforcement for participation provided between trials as necessary but not contingent on specific responses

Error Correction in Tested Trials

- ✓ No error correction procedures are used

Equivalence-Based Teaching: Lesson Template/Worksheet

Step One: Identify Content Area

Option 1: Intraverbals
Start with anything you might have typically taught as an intraverbal (check with Siri on whether this area is really best though of in an “equivalence” format first), including functions/functional categories of items (e.g., functions/features of vehicles, location of items in home, where animals live, etc.).

Option 2: General Academics
Consider ideas from the literature: coin value/identification, geography facts, definitions/examples of various terms, etc. What is the general category? (e.g. coin value, capital cities, English sentence types, etc.)

Content Area: ____

Step Two: Identify Subset Members For Stimulus Sets

a) What are the members of the category you chose, from a general perspective?

One way to think of this is to start with the “B” stimulus that is your “hub” or “node”, such as an item (e.g. couch, dime), and then identify (at least two) related pieces of information about them, such as location, function, value, etc. to be your A and C stimuli. At least one of the three (usually easiest to consider the B stimulus) should be a nonverbal stimulus. Think about this generally—e.g., B is pic of item, A is name of item, C is name of location where you find item.

A second way to think of this is to start with the combinatorially entailed response you are looking for, such as answering the question, “what can you find in the living room?” or “how much is a dime worth?” In these examples, there are two auditory/verbal stimuli—the main stimulus control of the question (living room, dime), and the main response (couch, 10c). These are your A and C stimuli—what can you call the general membership category? In these examples, we could say it was the name of the location/item in location or name of coin/value of coin. Then identify a “B” stimuli that links them —for example, a picture of the location or item, a picture of the coin or price tag.

A: ______________________

B: ______________________

C: ______________________

b) What are at least two subsets of the category you chose (e.g., living room vs kitchen, quarter vs dime, etc.)?

Subsets: 1)________________________________

2)________________________________

____

____

For each subset, identify the A, B, and C stimuli according to the general type of stimuli you identified above for at least one specific member per subset. For example, “couch”/pic of couch/“living room”; “refrigerator”/pic of refrigerator/“kitchen”

A1:____________________ A2:____________________

B1:____________________ B2:____________________

C1:____________________ C2:____________________

Step Three: Develop Teaching Plan

Depending on your student, you may wish to teach a tact first or a listener discrimination first. In one direction or the other, your first task is to teach the A-B and C-B relations, and then test for mutual entailment. Then you will review the A-B and C-B relations mixed together, and then test for combinatorial entailment (A-C). Use the relevant data sheet/plan on the next pages to specify your stimuli and instructions.

Your student should be able to derive the new A-C relation, but if not, re-train on the mixed A-B/C-B relations and try again. If your student has previously passed tests of combinatorial entailment it shouldn’t take more than one or two reviews of the mixed relations before they can derive the response. If they still do not derive the response, then teach *all* the relations together and then come up with a new set and start again.

Stimulus Set :
A1 (______):
B1 (______):
C1 (______):

A2 (______):
B2 (______):
C2 (______):

Equivalence Based Teaching Program: ________________________________

1. **Train Tact/Derived Listener Responding:**
   1.1. Train B→A _____________[holding B]?: *criteria=6 consecutive correct across exemplars*
   1.2. Test A→B ___________________[A]?: *criteria= 5/6 correct across exemplars*

Date	Train B1→A1								Train B2→A2								Test A1→B1:		Test A2→B2:	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -		+ -	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -		+ -	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					

2. Combinatorial Entailment: **Derived Intraverbals**
   2.1. Review relations B→A __________?, B→C ____________? *criteria=12 consecutive correct across exemplars (3 per exemplar)*
   2.2. Check mixed maintenance B→A, B→C without specific feedback: *criteria=8/8 consecutive correct across exemplars*
   2.3. Test A→C (__________?) and C→A (___________?): *criteria= 7/8 correct across exemplars*

Date	Review B1→A1				Review B1→C1				Review B2→A2				Review B2→C2							
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				

Date	Maint B1→A1				Maint B1→C1				Maint B2→A2				Maint B2→C2				Test AC 1	Test AC 2	Test CA 1	Test CA 2
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -

Stimulus Set :
A1 (______):
B1 (______):
C1 (______):

A2 (______):
B2 (______):
C2 (______):

Equivalence Based Teaching Program: ________________________________

1. **Train Listener Responding/Derived Tact:**
    1.1. Train A→B _____________[A]?: *criteria=6 consecutive correct across exemplars*
    1.2. Test B→A __________[holding B]?: *criteria= 5/6 correct across exemplars*

Date	Train A1→B1								Train A2→B2								Test B1→A1:		Test B2→A2:	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -		+ -	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -	+ -
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -		+ -	
	+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -		+ -	+ -	+ -					

2. Combinatorial Entailment: **Derived Intraverbals**
    2.1. Review relations A→B ___________?, C→B ____________? *criteria=12 consecutive correct across exemplars (3 per exemplar)*
    2.2. Check mixed maintenance A→B, C→B without specific feedback: *criteria=8/8 consecutive correct across exemplars*
    2.3. Test A→C (________________) and C→A (_______________]?): *criteria= 7/8 correct across exemplars*

Date	Review A1→B1				Review C1→B1				Review A2→B2				Review C2→B2							
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -				

Date	Maint A1→B1				Maint C1→B1				Maint A2→B2				Maint C2→B2				Test AC1	Test AC2	Test CA1	Test CA2
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -

Stimulus Set :
A1 (name):
B1 (animal):
C1 (sound):

A2 (name):
B2 (animal):
C2 (sound):

Multiple Exemplar Training for Coordination

Animal Names/Sounds

Review/train all relations, in random rotation:
Listener A-B: Which one is called [nameA]?/Find [nameA].
Tact B-A: What's his/her [hold picture B] name?/What's s/he [hold picture B] called?
Listener C-B: Which one says [soundC]?
Tact B-C: What does s/he [hold pic B] say?
Intraverbal A-C: What does [nameA] say?
Intraverbal C-A: Who says [soundC]?

Continue until 8 consecutive correct intraverbal responses (2 per relation), then re-assess with a new stimulus set.

Date	Lstnr A1B1	Lstnr A2B2	Tact B1A1	Tact B2A2	Lstnr C1B1	Lstnr C2B2	Tact B1C1	Tact B2C2	IV A1C1	IV A2C2	IV C1A1	IV C2A2
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P

Multiple Exemplar Training for Coordination:
Train Tact/Listener, Derive Intraverbal

Stimulus Set :
A1:
B1:
C1:
A2:
B2:
C2:

Review/train all relations, in random rotation:
Listener A-B: ____
Tact B-A: ____
Listener C-B: ____
Tact B-C: ____
Intraverbal A-C: ____
Intraverbal C-A: ____

Continue until 8 consecutive correct intraverbal responses (2 per relation), then re-assess with a new stimulus set.

Date	Lstnr A1B1	Lstnr A2B2	Tact B1A1	Tact B2A2	Lstnr C1B1	Lstnr C2B2	Tact B1C1	Tact B2C2	IV A1C1	IV A2C2	IV C1A1	IV C2A2
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P
	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P	I P

Curricular Sequence: Same/Different Responding

Early Learners

1. Trained same matching (teaching specific matching targets)

Mid-Level 2 Learners

2. Generalized identity matching (novel stimuli)
3. Oddity matching
4. Identical pair matching

High Level 2 Learners

5. Same/different pair matching
6. Contextually-controlled first-order same/different responding: LR and Tact

Level 3 Learners

7. Contextually-controlled second-order same/different responding: LR and Tact

Advanced Learners

8. Arbitrary same/different relational responding (see transition from nonarbitary to arbitrary protocols)

1. Trained same matching (teaching specific matching targets)

General Notes

- Use standard discrete trial teaching procedures for match-to-sample and also for selection
- Data sheet should indicate specific targets, array size, and whether response was independent or prompted (or correct or incorrect); ideally trial-by-trial data should be collected to determine if responding is above chance levels. (Sample follows but any standard trial-by-trial data sheet may be used)
- Begin with 3-5 specific object targets. Continue adding new targets as initial targets are acquired, until student can match at least 20 specifically taught targets in an array of at least 3.
- Begin with a physical match-to-sample (student puts sample with correct comparison).
- Once student can match some objects, also work on matching pictures.
- Once student can match objects to objects and pictures to pictures, work on matching identical objects to pictures (i.e. photos of objects).
- Once student has a reasonable repertoire of physical matches, also work on matching by selection (showing sample and student selects correct comparison—"find same").
- Additional sensory modalities may also be targeted for more advanced students: auditory, tactile, olfactory; also generalize to more abstract visual samples (line drawings etc.). It is not necessary for these to be mastered before moving to next level though.

Program: **Trained Same Matching**
Materials/Visual SD: __objects __pictures
Verbal SD: ____“Put with same” ___ “Find same”
Array: ________

Current targets:

Date																				% independent
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	
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Criteria for mastery: 3 days in a row first trial independent; *when target is mastered, move to mastered list for generalization and introduce new target*

2. Generalized identity matching (novel stimuli)

General Notes

- Begin working on generalized identity matching once a student has a reasonable repertoire of taught matching and is learning new matches quickly.
- Utilize sets of identical pairs of stimuli with a random selection of targets, as follows:
  Select sample and comparison stimuli using the following quasi-random selection procedure:
    - *Use 10 different pairs each consisting of 2 identical pictures.*
    - *Turn the pairs face down and put in 10 piles.*
    - *Pick one pair (SAMPLE AND COMPARISON) and take one picture from another pair (OTHER COMPARISON).*
    - *Put the pair aside after the trial and put the single card back with its partner.*
    - *Make another random choice.*
    - *When the last pair is left, take one extra card one of the nine pairs that have already served as a SAMPLE and COMPARISON pair.*
    - *Replace the 10 pairs and repeat until termination criteria are met.*
- Work on both physical matching (putting sample with correct comparison) and selection-based matching (finding the correct comparison when shown a sample)
- Once a student has reached pass criteria with a given set of stimuli (10 pairs), begin using a new set of stimuli
- If stimulus sets are not mastered relatively quickly, return to trained same matching with specific targets
- Mastery of this level requires first trial correct responding with a novel set of stimuli
- Additional sensory modalities may also be targeted for more advanced students: auditory, tactile, olfactory; also generalize to more abstract visual samples (line drawings etc.). It is not necessary for these to be mastered before moving to next level though.

Program: **Identity Matching**
Materials/Visual SD: __objects __pictures
Verbal SD: ____"Put with same" ___ "Find same"
Current stimulus set#__________

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Criteria for stimulus set mastery: 10/10 consecutive correct
Criteria for skill mastery: 10/10 first trial correct with new stimulus set

3. Oddity Matching

<u>General Notes</u>

- In general, begin working on oddity matching once a student has generalized identity matching; *however,* it is possible to use oddity to teach identity so if identity is not progressing you might want to try oddity
- Use standard discrete trial presentation and correction procedures
- Utilize sets of identical stimuli with a random selection of targets, as follows:
  Select sample and comparison stimuli using the following quasi-random selection procedure:
    - *Use 10 different sets each consisting of multiple (up to 8) identical pictures.*
    - *Turn the sets face down and put in 10 piles.*
    - *Pick one set (SAME) and take one picture from another pair (ODD). Randomize placement of the cards.*
    - *Put the set aside after the trial and put the single card back with its set.*
    - *Make another random choice.*
    - *When the last set is left, take one extra card one of the nine set that have already served as a SAMPLE and COMPARISON pair.*
    - *Replace the 10 sets and repeat until termination criteria are met.*
- Begin with 8 identical and 1 odd, then fade until you can maintain success with 2 identical and 1 odd

Program: **Oddity Matching**
Materials/Visual SD: __objects __pictures
Verbal SD: “Find different”
Array: ___ #same/1odd

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Criteria for stimulus set mastery: 10/10 consecutive correct
Criteria for skill mastery: 10/10 first trial correct with new stimulus set

4. Identical pair matching

<u>General Notes:</u>

- *If this curriculum level does not move quickly, it may be out of sequence. Move to the next level (beyond pair matching) and return to this one afterwards.*
- Utilize sets of same pairs (items in pair are identical, e.g. cat and cat) and sets of difference pairs (items in pair are different, e.g. dog and cow) of stimuli with a random selection of targets, as follows:

  Select sample and comparison stimuli using the following quasi-random selection procedure:
    - *Use 10 different pairs each consisting of 2 identical pictures for the sample and the SAME comparison. Use 5 different pairs each consisting of 2 different pictures for the DIFFERENT comparison.*
    - *Turn the pairs face down and put in piles.*
    - *Pick two pairs (SAMPLE and SAME COMPARISON) from the SAME comparison set and take one pair from the difference pair (DIFFERENT COMPARISON).*
    - *Use sample/comparison plates/target areas or other means to make it clear that each pair is a single compound stimulus*
    - *Put the pairs aside after the trial and make another random choice.*
    - *Replace the pairs and repeat until termination criteria are met.*
- At this level, only SAME is being targeted for teaching. Use specific feedback in reinforcement: e.g., "These both show a pair that's the SAME"
- Once a student has reached pass criteria with a given set of stimuli (10 pairs SAME/5 pairs DIFFERENT), begin using a new set of stimuli
- Mastery of this level requires first trial correct responding with a novel set of stimuli

Program: **Identical Pair Matching**
Verbal SD: ___ “Find same”
Current stimulus set#__________

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Criteria for stimulus set mastery: 10/10 consecutive correct
Criteria for skill mastery: 10/10 first trial correct with new stimulus set

5. Same/different pair matching

<u>General Notes:</u>

- *If this curriculum level does not move quickly, it may be out of sequence. Move to the next level and return to this one afterwards.*
- Utilize sets of same pairs (items in pair are identical, e.g. cat and cat) and sets of difference pairs (items in pair are different, e.g. dog and cow) of stimuli with a random selection of targets, as follows:

  Select sample and comparison stimuli using the following quasi-random selection procedure:
    - *Use 10 different pairs each consisting of 2 identical pictures for the sample and the SAME comparison. Use 5 different pairs each consisting of 2 different pictures for the DIFFERENT comparison.*
    - *Turn the pairs face down and put in piles.*
    - *Pick two pairs (SAMPLE and SAME COMPARISON) from the SAME comparison set and take one pair from the difference pair (DIFFERENT COMPARISON).*
    - *Use sample/comparison plates/target areas or other means to make it clear that each pair is a single compound stimulus*
    - *Put the pairs aside after the trial and make another random choice.*
    - *Replace the pairs and repeat until termination criteria are met.*
- At this level, both SAME and DIFFERENT are being targeted for teaching. Use the SD "Where does it go?" or something similar (*don't* use "find same"). Use specific feedback in reinforcement: e.g., "These both show a pair that's the SAME" or "These both show a pair that is DIFFERENT"
- Begin teaching in blocks of 3 trials each as for working on contextually controlled LR and tact responding and then move to random rotation of SAME/DIFFERENT.
- Once a student has reached pass criteria with a given set of stimuli (10 pairs SAME/5 pairs DIFFERENT), begin using a new set of stimuli
- Mastery of this level requires first trial correct responding with a novel set of stimuli

Program: Contextually Controlled Same/Different—Nonarbitrary Pair Matching

1. Mixed Same/Different across blocks
   - Alternate blocks of 3 trials; provide block of 3 trials of the type an error made on following correction procedure: *criteria=7/8 consecutive correct responses*
2. Mixed Same/Different in random rotation
   - Alternate presentation of SAME/DIFFERENT quasi-randomly: *criteria=7/8 consecutive correct responses*

SD: Where does it go?/Where does it belong?

Date	Step	SAME				DIFFERENT				SAME				DIFFERENT			
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Data Collection Instructions: Highlight current step of program. Circle correct/incorrect each trial presentation; score right to left and top to bottom, using as many rows as needed. Move to next data block when an error is made to facilitate tracking consecutive correct responses. Do not score trials within a correction procedures. Fill in date for each teaching session on first row used for session. End session after either 25 trials total, reaching pass criteria for that step, or based on student motivation. At end of each teaching session highlight trials indicating pass criteria (if reached).

6. Contextually-controlled first-order same/different responding: LR and Tact

Materials:
At least two sets of 10 pictures of easily discriminable objects with two identical copies of every picture. A quasi-random selection procedure will be used for selecting stimuli for each trial, as detailed in each procedure.

Procedure:

NOTE: It may be necessary to work on DIFFERENT alone prior to introducing mixed Same/Different. Use the same procedures and data sheets as for training targets for same and teaching generalized identity matching but teach the cue "find DIFFERENT".

1. <u>Mixed Same/Different across blocks—Listener responding:</u>
   - Use a standard discrimination procedure with a comparison array of two different pictures and a sample that is the same as one of the comparisons. Select sample and comparison stimuli using the following quasi-random selection procedure:
     - *Use 10 different pairs each consisting of 2 identical pictures.*
     - *Turn the pairs face down and put in 10 piles.*
     - *Pick one pair (SAMPLE AND COMPARISON) and take one picture from another pair (OTHER COMPARISON).*
     - *Put the pair aside after the trial and put the single card back with its partner.*
     - *Make another random choice.*
     - *When the last pair is left, take one extra card one of the nine pairs that have already served as a SAMPLE and COMPARISON pair.*
     - *Replace the 10 pairs and repeat until termination criteria are met.*
   - When introducing this task for the first time (or as needed, based on teacher judgement), use a correction procedure for the first *three* trials to demonstrate alternating between same/different, alternating a verbal instruction of either "Which one is the *same*?" or "Which one is *different*?"
   - Present blocks of three "same" trials and then three "different" trials. Use standard correction procedures when an error is made, followed by three trials of the type on which the error was made (e.g., if an error was made with "same", then do correction followed by three same trials).
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

2. <u>Mixed Same/Different in random rotation—Listener responding:</u>
   - Use a standard discrimination procedure with a comparison array of two different pictures and a sample that is the same as one of the comparisons.
   - Use the same quasi-random selection procedure as above to select stimuli.
   - Alternate SAME ("Which one is the *same*?") and DIFFERENT ("Which one is *different*?") trials quasi-randomly. In other words, present trials in pairs involving one SAME and one DIFFERENT trial, but pick the first relation in each pair at random to make sure that trials are not simply alternating predictably between SAME and DIFFERENT.
   - Use standard correction procedures.

- Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

3. <u>Mixed Same/Different in random rotation—Tact:</u>
   - Tell the student "Now we're going to talk about same and different. I am going to show you some pictures, and you can tell me if they are the same or different."
   - Place two pictures in front of the student, randomly alternating between whether the pictures are the same as or different from each other using a quasi-random selection procedure:
     - *Use 10 different pairs each consisting of 2 identical pictures.*
     - *Turn the pairs face down and put in 10 piles.*
     - *On each trial, either pick one pair (for a SAME relation) or pick one card from each of two piles (DIFFERENT relation).*
     - *Put the pile or piles that were used to one side.*
     - *Make another random choice.*
     - *If only one pile is left and a difference trial is needed then select one card from a pile that has been put aside.*
     - *Repeat as necessary until termination criteria are met.*
   - If the student does not respond, initially prompt with a neutral statement such as "Tell me about these pictures." Prompt an appropriate response by asking "Are these pictures the same or different?" if necessary.
   - Use standard correction procedures.
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

Additional advanced options:

- <u>Auditory-auditory same/different</u>: Tell the student you are going to say two words, and he needs to tell you if you are saying the same words or different words. Use a set of text card pairs to select the words as you would use picture cards for visual-visual matching; pictures or text may be utilized as prompts to aid teaching.
- Other sense modalities same/different. Follow similar procedures for tactile, olfactory, etc.

Program: Contextually Controlled Same/Different—Nonarbitrary

3. Mixed Same/Different across blocks—Listener responding ("Which one is the *same/different?*")
    - Alternate blocks of 3 trials; provide block of 3 trials of the type an error made on following correction procedure: *criteria=7/8 consecutive correct responses*
4. Mixed Same/Different in random rotation—Listener responding ("Which one is the *same/different?*")
    - Alternate presentation of SAME/DIFFERENT quasi-randomly: *criteria=7/8 consecutive correct responses*
5. Mixed Same/Different in random rotation—Tact
    - Alternate presentation of SAME/DIFFERENT quasi-randomly: *criteria=7/8 consecutive correct responses*

Date	Step	SAME				DIFFERENT				SAME				DIFFERENT			
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Data Collection Instructions: Highlight current step of program. Circle correct/incorrect each trial presentation; score right to left and top to bottom, using as many rows as needed. Move to next data block when an error is made to facilitate tracking consecutive correct responses. Do not score trials within a correction procedures. Fill in date for each teaching session on first row used for session. End session after either 25 trials total, reaching pass criteria for that step, or based on student motivation. At end of each teaching session highlight trials indicating pass criteria (if reached).

7. **Contextually-controlled second-order same/different responding: LR and Tact**

Materials:
Multiple sets of two shapes in two colors (e.g. one set=red triangle, red square, yellow triangle, yellow square). A quasi-random selection procedure will be used for selecting stimuli for each trial, as detailed in each procedure.

This procedure can also be done with other attributes such as size, or category, features, etc.

Procedure:

Same

1. <u>Mixed Same by attribute across blocks—Listener responding:</u>
    - Use a standard discrimination procedure with a comparison array of two different shapes in different colors and a sample that is the same color but different shape/same shape but different color as one of the comparisons (e.g. comparisons = red triangle, yellow square; sample = red square). Select sample and comparison stimuli using the following quasi-random selection procedure:
        - *Use 10 different sets each consisting of 2 shapes in 2 colors. For each set, separate the shapes into two stacks with each stack being 2 different shapes and 2 different colors (e.g., red triangle/yellow square, yellow triangle/red square)*
        - *Pick one set and select one stack as the comparison array and take one shape from the other stack pair as the sample.*
    - When introducing this task for the first time (or as needed, based on teacher judgement), use a correction procedure for the first *three* trials to demonstrate alternating between color and shape, alternating a verbal instruction of either "Which one is the *same color*?" or "Which one is the *same shape*?"
    - Present blocks of three "same color" trials and then three "same shape" trials. Use standard correction procedures when an error is made, followed by three trials of the type on which the error was made (e.g., if an error was made with "same color", then do DGI followed by three same color trials).
    - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration

2. <u>Mixed Same by attribute in random rotation—Listener responding:</u>
    - Use a standard discrimination procedure with comparison arrays and samples as above.
    - Use the same quasi-random selection procedure as above to select stimuli.
    - Alternate SAME COLOR ("Which one is the *same color*?") and SAME SHAPE ("Which one is *the same shape*?") trials quasi-randomly. In other words, present trials in pairs involving one SAME COLOR and one SAME SHAPE trial, but pick the first attribute in each pair at random to make sure that trials are not simply alternating predictably between color and shape. Cards labeled color/shape may be used to select the attribute to be tested.
    - Use standard correction procedures.
    - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

3. <u>Mixed Same by attribute in random rotation—Tact:</u>
   - Tell the student "Now we're going to talk about colors and shapes. I am going to show you some things, and you can tell me if they are the same color or the same shape."
   - Place two shapes in front of the student, randomly alternating between whether the pictures are the same shape (but different colors) or same color (but different shapes) from each other using a quasi-random selection procedure:
     - *Use 10 different pairs; half should be same shape but different colors and half should be same color but different shapes*
     - *Use a card labeled shape/color to select the attribute to be tested; alternate quasi-randomly by picking a card for the first trial and then using the other attribute for the next trial; repeat the random selection on the following trial and so on.*
     - *Put the pair that was used to one side following each trial.*
     - *Repeat as necessary until termination criteria are met.*
   - If the student does not respond, initially prompt with a neutral statement such as "Tell me about these." Prompt an appropriate response by asking "Are these the same color or the same shape?" if necessary.
   - Use standard correction procedures.
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

Different

4. <u>Mixed Different by attribute across blocks—Listener responding:</u>
   - Use a standard discrimination procedure with a comparison array of two different shapes in different colors and a sample that is the same color but different shape or same shape but different color as one of the comparisons (e.g. comparisons = red triangle, yellow square; sample = red square). Select sample and comparison stimuli using the following quasi-random selection procedure:
     - *Use 10 different sets each consisting of 2 shapes in 2 colors. For each set, separate the shapes into two stacks with each stack being 2 different shapes and 2 different colors (e.g., red triangle/yellow square, yellow triangle/red square)*
     - *Pick one set and select one stack as the comparison array and take one shape from the other stack pair as the sample.*
   - When introducing this task for the first time (or as needed, based on teacher judgement), use a correction procedure for the first *three* trials to demonstrate alternating between color and shape, alternating a verbal instruction of either "Which one is a *different color*?" or "Which one is a *different shape*?"
   - Present blocks of three "different color" trials and then three "different shape" trials. Use standard correction procedures when an error is made, followed by three trials of the type on which the error was made (e.g., if an error was made with "different color", then do DGI followed by three different color trials).
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

5. Mixed Different by attribute in random rotation—Listener responding:
   - Use a standard discrimination procedure with comparison arrays and samples as above.
   - Use the same quasi-random selection procedure as above to select stimuli.
   - Alternate DIFFERENT COLOR ("Which one is a *different color*?") and DIFFERENT SHAPE ("Which one is *a different shape*?") trials quasi-randomly. In other words, present trials in pairs involving one DIFFERENT COLOR and one DIFFERENT SHAPE trial, but pick the first attribute in each pair at random to make sure that trials are not simply alternating predictably between color and shape. Cards labeled color/shape may be used to select the attribute to be tested (as below).
   - Use standard correction procedures.
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

6. Mixed Different by attribute in random rotation—Tact:
   - Tell the student "Now we're going to talk about the colors and shapes. I am going to show you some things, and you can tell me if they are a different color or a different shape."
   - Place two shapes in front of the student, randomly alternating between whether the pictures are different shapes (but the same colors) or different colors (but the same shapes) from each other using a quasi-random selection procedure:
     - *Use 10 different pairs; half should be same shape but different colors and half should be same color but different shapes*
     - *Use a card labeled shape/color to select the attribute to be tested; alternate quasi-randomly by picking a card for the first trial and then using the other attribute for the next trial; repeat the random selection on the following trial and so on.*
     - *Put the pair that was used to one side following each trial.*
     - *Repeat as necessary until termination criteria are met.*
   - If the student does not respond, initially prompt with a neutral statement such as "Tell me about these." Prompt an appropriate response by asking "Are these a different color or a different shape?" if necessary.
   - Use standard correction procedures.
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

Mixed Same/Different

7. Mixed Same/Different by attribute across blocks—Listener responding:
   - Use a standard discrimination procedure with a comparison array of two different shapes in different colors and a sample that is the same color but different shape/same shape but different color as one of the comparisons (e.g. comparisons = red triangle, yellow square; sample = red square). Select sample and comparison stimuli using the following quasi-random selection procedure:
     - *Use 10 different sets each consisting of 2 shapes in 2 colors. For each set, separate the shapes into two stacks with each stack being 2 different shapes and 2 different colors (e.g., red triangle/yellow square, yellow triangle/red square)*

- *Pick one set and select one stack as the comparison array and take one shape from the other stack pair as the sample.*
- When introducing this task for the first time (or as needed, based on teacher judgement), use a correction procedure for the first *five* trials to demonstrate alternating between color and shape, alternating a verbal instruction of either "Which one is the *same color*?" or "Which one is the *same shape*?" or "Which one is a *different color*?" or "Which one is a *different shape*?"
- Present blocks of three "same color" trials, three "same shape" trials, three "different color" trials and three "different shape" trials. Use standard DGI procedures when an error is made, followed by three trials of the type on which the error was made (e.g., if an error was made with "same color", then do DGI followed by three same color trials).
- Pass criteria: 11/12 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

8. Mixed Same/Different by attribute in random rotation—Listener responding:
   - Use a standard discrimination procedure with comparison arrays and samples as above.
   - Use the same quasi-random selection procedure as above to select stimuli.
   - Alternate SAME COLOR ("Which one is the *same color*?"), SAME SHAPE ("Which one is *the same shape*?"), DIFFERENT COLOR ("Which one is a *different color*?") and DIFFERENT SHAPE ("Which one is *a different shape*?") trials quasi-randomly:
     - *Use four cards labeled same color/same shape/different color/different shape to select which relation and attribute to test on a given trial*
     - *Select a card at random for each trial; set aside; repeat until all four cards have been used*
     - *Shuffle the cards and repeat*
   - Use standard correction procedures.
   - Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

9. Mixed Same/Different by specified attribute in random rotation—Tact:
   - Tell the student "Now we're going to talk about colors and shapes. I am going to show you some shapes, and you can tell me about their color or their shape. If I ask you to tell me about their color, you can tell me if they are the same color or different colors. If I ask you to tell me about their shape, you can tell me if they are the same shape or different shapes."
   - Place two shapes in front of the student, randomly alternating between whether the pictures are the same shape (but different colors) or same color (but different shapes) from each other using a quasi-random selection procedure:
     - *Use 10 different pairs; half should be same shape but different colors and half should be same color but different shapes*
     - *Use a card labeled shape/color to select the attribute to be tested; alternate quasi-randomly by picking a card for the first trial and then using the other attribute for the next trial; repeat the random selection on the following trial and so on.*
     - *Put the pair that was used to one side following each trial.*
     - *Repeat as necessary until termination criteria are met.*

- For each trial, specify what attribute to describe: "Tell me about the color/shape.", as selected above. Prompt an appropriate response by asking "Are these the same color/shape or different colors/shapes?" if necessary.
- Use standard correction procedures.
- Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

10. <u>Mixed Same/Different by attribute in random rotation—Tact:</u>
- Tell the student "Now we're going to talk about colors and shapes. I am going to show you some shapes, and you can tell me about their color and their shape. When I show them to you, you tell me what is the same and what is different."
- Place two shapes in front of the student, randomly alternating between whether the pictures are the same shape (but different colors) or same color (but different shapes) from each other using a quasi-random selection procedure:
  - *Use 10 different pairs; half should be same shape but different colors and half should be same color but different shapes*
  - *Put the pair that was used to one side following each trial.*
  - *Repeat as necessary until termination criteria are met.*
- For each trial give a neutral prompt as necessary, such as "Tell me about these—what is same and different?" Prompt an appropriate response by asking "Are these the same color/shape or different colors/shapes?" if necessary.
- Use standard correction procedures.
- Pass criteria: 7/8 consecutive correct responses with a novel set of stimuli (without any initial demonstration)

Program: Contextually Controlled Same/Different—Nonarbitrary Second Order

Same

1. Mixed Same by attribute across blocks—Listener responding ("Which one is the *same color/shape*?")
2. Mixed Same by attribute in random rotation—Listener responding ("Which one is the *same color/shape*?")
3. Mixed Same by attribute in random rotation—Tact (see procedure sheet for cues and prompts)

Different

4. Mixed Different by attribute across blocks—Listener responding ("Which one is a *different color/shape*?")
5. Mixed Different by attribute in random rotation—Listener responding ("Which one is a *different color/shape*?")
6. Mixed Different by attribute in random rotation—Tact (see procedure sheet for cues and prompts)

Same/Different

7. Mixed Same/Different by attribute across blocks—Listener responding ("Which one is the *same/different color/shape*?")
8. Mixed Same/Different by attribute in random rotation—Listener responding ("Which one is the *same/different color/shape*?")
9. Mixed Same/Different by specified attribute in random rotation—Tact (see procedure sheet for cues and prompts)
10. Mixed Same/Different by attribute in random rotation—Tact (see procedure sheet for cues and prompts)

Date	Step	SAME COLOR				SAME SHAPE				DIFFERENT COLOR				DIFFERENT SHAPE			
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Data Collection Instructions: Highlight current step of program. Circle correct/incorrect each trial presentation; score right to left and top to bottom, using as many rows as needed. Move to next data row when an error is made to facilitate tracking consecutive correct responses. Do not score trials within a correction procedures. Fill in date for each teaching session on first row used for session. End session after either 25 trials total, reaching pass criteria for that step, or based on student motivation. At end of each teaching session highlight trials indicating pass criteria (if reached).

Same/Different Transition to Arbitrary

1. **NON-Arbitrary same/different relational responding**

Procedure:

Talk about what foods your student likes. Then, tell the student, "We are going to learn some more about [the crazy animals—or you can use people, pets, etc., whatever is motivating for the student]. Just like you, these [animals] like different things to eat. We're going to learn that some animals like the *same* foods as their friends*,* and some animals like foods that are *different*."

A: visual+auditory (pictures of animals+spoken names— "crazy animals"—see stimulus set table—or use pictures of real animals, people, etc.)
B: visual+auditory (pictures of animals+spoken names)

Note: It can be an additional motivating element to allow your student to pick the stimuli (out of a bag, cards out of a "deck", etc.)

1. SAME/DIFFERENT TRAINING (A→B)
   Introduction*:* Lay out the 4x2 grid with animals/names in the first column, and foods in the second column. Here are some animals. This one [show and name A1] likes [show and name, e.g. strawberry milkshakes]. This one [show and name A2] likes [pizza]. They have friends, and some of their friends like the same thing and some like different things. (repeat for the B1/ B2 and the foods they like)
   1. Test/Train A1→B1 Same: ""[A] likes the same food as...?""
   2. Test/Train A1→B2 Different: "[A] likes different food from...?""
   3. Introduce second sample stimulus
      - Repeat steps 1 and 2 with A2 as the sample stimulus
   4. Test maintenance mixed same/different A1/A2
      - Randomly alternate A1 and A2 as sample stimuli
      - Randomly present trials of SAME and DIFFERENT
   5. Repeat step 4 with a new stimulus set and randomly alternate A1/A2/B1/B2 as sample stimuli and randomly present trials of SAME/DIFFERENT

Pass criteria at each stage: 7/8 consecutive correct

Program: Same/Different NONArbitrary

1. Same/Different Training
    1.1. Train A1→B1 SAME ("Which one likes the *same* food as [A]?"): *criteria=7/8 consecutive correct across exemplars*
    1.2. Train A1→B2 DIFFERENT ("Which one likes *different* food than [A]?"): *criteria=7/8 consecutive correct across exemplars*
    1.3. Train A2→B2 SAME ("Which one likes the *same* food as [A]?"): *criteria=7/8 consecutive correct across exemplars*
    Train A2→B1 DIFFERENT ("Which one likes *different* food than [A]?"): *criteria=7/8 consecutive correct across exemplars*
    1.4. *Maintenance:* A1/A2 samples, randomly alternate SAME/DIFFERENT *criteria=8/8 consecutive correct across exemplars*
    1.5. *Maintenance: NEW STIMULUS SET; random rotation of samples and same/different*

Date	Stim set	Step	A1-B1 SAME				A1-B2 DIFFERENT				A2-B2 SAME				A2-B1 DIFFERENT			
			+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
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2. **Arbitrary CD: Who likes what?**

Procedure:

Talk about what foods your student likes. Then, tell the student, "We are going to learn some more about [the crazy animals—or you can use people, pets, etc., whatever is motivating for the student], and what they like to eat.

A: visual+auditory (pictures of animals+spoken names— "crazy animals"—see stimulus set table—or use pictures of real animals, people, etc.)
B: visual+auditory (pictures of animals+spoken names)
C: visual+auditory (pictures of animals+spoken names)

D, E: Colors of candy or names of food: text

> Note: It can be an additional motivating element to allow your student to pick the stimuli (out of a bag, cards out of a "deck", etc.)

1. <u>TRAINING</u>
   <u>Introduction:</u> Lay out the 4x2 grid with animals/names in the first column, and a list of two foods to the side. Here are some animals. This one [show and name A] likes [show and name, D or E e.g. strawberry milkshakes]. This one [show and name B] likes [show and name D or E e.g. pizza]. This one [show and name C] likes [show and name D or E e.g. pizza].
   <u>Test/Train animal->food</u> "What does [A]/[B]/[C] like?"
   - Randomize which stimulus is asked about on each trial.
   - Use standard discrete trial training procedures. Responses should be vocal but the student can also point to the appropriate text card in the list.
   - Mastery criteria is set at three consecutive correct responses per stimulus item.
   - When one stimulus set (all three stimuli) has been mastered, additional stimulus sets may be used until the student is able to learn a new set within 10-15 trials.

Program: Arbitrary CD: Who likes what?

SD: "What does [animal] like?"

	animal-food				animal-food				animal-food			
Date												
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3. Exclusion: Who likes what?

Procedure:

Talk about what foods your student likes. Then, tell the student, "We are going to learn some more about [the crazy animals—or you can use people, pets, etc., whatever is motivating for the student], and what they like to eat.

A: visual+auditory (pictures of animals+spoken names— "crazy animals"—see stimulus set table—or use pictures of real animals, people, etc.)
B: visual+auditory (pictures of animals+spoken names)

food1/2: Colors of candy or names of food: text

> Note: It can be an additional motivating element to allow your student to pick the stimuli (out of a bag, cards out of a "deck", etc.)

1. TRAINING
   Introduction: Lay out the 4x2 grid with two animals/names in the first column, and a list of two foods to the side. Here are some animals. One of them likes [food1] and one of them likes [food2].

   Test/Train animal->food "This one [show and name A] likes [show and name, food1 e.g. strawberry milkshakes]. What does [B] like?"
   - After a correct trial, repeat with a new stimulus selection (i.e. new A/B/C/D)
   - Randomize which stimulus (A or B) is asked about with each new stimulus set.
   - Use standard discrete trial training procedures. Responses should be vocal but the student can also point to the appropriate text card in the list.
   - Mastery criteria is set at 5/6 correct first trial responses across stimulus sets.

Program: Exclusion: Who likes what?

SD: "[Animal 1] likes [food 1]. What does [animal 2] like?"

Set #

Date																		
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4. **Nonarbitrary auditory same/different responding**

Procedure:

Talk about what foods your student likes. Then, tell the student, "We are going to learn some more about [the crazy animals—or you can use people, pets, etc., whatever is motivating for the student]. Just like you, these [animals] like different things to eat. We're going to learn that some animals like the *same* foods as their friends, and some animals like foods that are *different*. I'm going to tell you what foods the animals like, and you'll tell me if they like the same or different"

A: visual+auditory (pictures of animals+spoken names— "crazy animals"—see stimulus set table—or use pictures of real animals, people, etc.)
B: visual+auditory (pictures of animals+spoken names)

Note: It can be an additional motivating element to allow your student to pick the stimuli (out of a bag, cards out of a "deck", etc.)

Additional materials: paired sets of either same or different food/color names (e.g yellow/yellow, green/red, pizza/popcorn etc.)

1. SAME/DIFFERENT TRAINING (A-B)
Lay out the 4x2 grid with animals/names in the first column. Randomly select a pair of either same or different food names (but do not show them to the student). Here are some animals. [A] likes [name food1]. [B] likes [name food2]. Do they like the same or different food?

- After a correct trial, repeat with a new stimulus selection (i.e. new food name selection and if needed new A/B)
- Randomize whether a SAME or DIFFERENT pair of food names is used with each new stimulus set.
- Use standard discrete trial training procedures. If student is not successful with random rotation of same/different, used blocked responding with 3 trials of each type correct before switching to the other type. For training purposes, visual stimuli (pics of the food) may be used as prompts.
- Mastery criteria is set at 5/6 consecutive correct first trial responses in random rotation of same/different across stimulus sets.

Program: Auditory Same/Different—Nonarbitrary

"A likes [food1], B likes [food 2]. Do they like same or different?"

Date	Set	SAME				DIFFERENT				SAME				DIFFERENT			
		+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
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Arbitrary same/different relational responding: MTS training/derived Trained Relation ToF Topographical Test

Procedure:

Talk about what foods your student likes. Then, tell the student, "We are going to learn some more about [the crazy animals—or you can use people, pets, etc., whatever is motivating for the student]. Just like you, these [animals] like different things to eat. We're going to learn that some animals like the *same* foods as the one you'll see, and some animals like foods that are *different*."

Materials

Whiteboard or other area to write out relations and food options.

Preparation for each set: Write down three animals or other characters on the board with blank lines next to them, and write down two foods separately.

E.g.:

lion ____________
tiger ___________
bear ____________

candy
ice cream

1. DIFFERENT:
   - B→A Same
     - Write out: "[B] likes the *same* food as [A]"
   - B→C Different
     - Write out: "[B] likes *different* food than [C]"

   B-A Same: Ask—Do [B] and [A] like the same or different food?
   B-C Different: Ask—Do [B] and [C] like the same or different food?

   Trained/ToF DERIVED DIFFERENT TEST (C→B)

   Say: "[C] likes [food1]" and write the food next to [C] on the board.
   Ask: "What does [B] like?" Student may either vocally respond, or write down next to [B] the food.

2. SAME:
   - B→C Different
     - Write out: "[B] likes *different* food than [C]"
   - B→A Same
     - Write out: "[B] likes the *same* food as [A]"

   B-C Different: Ask—Do [B] and [C] like the same or different food?

B-A Same: Ask—Do [B] and [A] like the same or different food?

Trained/ToF DERIVED SAME TEST (A→B)

Say: "[A] likes [food1]" and write the food next to [A] on the board.

Ask: "What does [B] like?" Student may either vocally respond, or write down next to [B] the food.

Select a new stimulus set (A/B/C and foods) and repeat for a total of 6 Trained/ToF tests with a total of 3 DIFFERENT and 3 SAME tests. Randomly alternate SAME/DIFFERENT.

For training: Use multiple food sets with each animal stimulus set and train through standard correction procedures. Test with a new animal stimulus set.

Topographical Test: Trained/ME Relation ToF
Student:

Date/ Session #	Set 1 S D	Set 2 S D	Set 3 S D	Set 4 S D	Set 5 S D	Set 6 S D	Total
1							

Set 1
A:
B:
C:
food1:
food2:

Set 2
A:
B:
C:
food1:
food2:

Set 3
A:
B:
C:
food1:
food2:

Set 4
A:
B:
C:
food1:
food2:

Set 5
A:
B:
C:
food1:
food2:

Set 6
A:
B:
C:
food1:
food2:

Teaching Protocol: Spatial Relations
Contextually-Controlled Nonarbitrary Relational Responding

Goal: Student will be able to respond in accordance with the spatial relation between object pairs for at least three different examples of spatial relations (e.g., on top of/under, in front of/behind, left/right), for both objects in both relations (e.g., on top of/under) in the spatial relationship, for novel object pairs.

When to introduce:
- *Phase 1 (matching):* Student demonstrates identity matching with visual stimuli
- *Phase 2 (listener)*: Student is able to follow a variety of instructions as a listener, including… and can discriminate a wide variety of common objects [id from VB-MAPP]
- *Phase 3a, b, c, d (tacting):* Student is able to tact a wide variety of common objects [ie from VB-MAPP]. Student demonstrates mutual entailment for visual-auditory discriminations in frames of coordination (e.g. if taught to tact an item, can respond as a listener or vice versa)

Materials/Setting:
- Teacher and student should sit on the same side of the table in order to ensure the spatial relations are observed from the same perspective (e.g., the item "in front" from the student's perspective is also the item "in front" from the teacher's perspective)
- Multiple sets of common items which can be placed in relation to each other. Student should be able to tact and discriminate all items used for Phases 2 and 3; items must be able to serve the function of being placed in multiple positions in relation to each other (e.g. must be able to be both "on top" of something else as well as "under" something else).
- To facilitate progression to *Arbitrary* protocols and allow for ease of placement as well as randomization of items, picture cubes with interchangeable pictures of common objects are ideal. If unavailable, different colored blocks are logistically easy; some children may find actual objects more motivating.

Procedure:
Within each phase, teach one relation before moving on to the next, as follows:
1. On top of/under
2. In front of/behind (*note: using objects with defined fronts/backs such as vehicles or animals or people/characters is recommended)*
3. Left of/right of

- All relations should be well generalized (objects, settings, people) before moving from one phase to the next.
- Standard correction/DGI procedures should be used throughout, with verbal instructions as noted.
- Alternate trials quasi-randomly between the two paired elements of the relation (e.g. between "on top of" and "under") within each phase
- Vary materials used, and ensure that objects that are used in multiple positions (i.e. in both relations to each other).

Phase 1: Matching based on spatial relations

Note: Pictures of various object pairs as well as real objects, colored blocks, or photo cubes may be used for this phase.

- Verbal instructions: *Find the right one*
- Use standard MTS procedures, with sample/comparisons as described below.
- Pass criteria: 8 consecutive correct
- Termination criteria: 8 cumulative incorrect

Phase 1a: Identical objects

Sample: randomly select a wide variety of objects within the spatial relation being taught; e.g., an eraser on top of a car, a block on top of an eraser, red block on top of blue block, etc.
Comparisons: using object pairs identical to the sample, put one pair in the same configuration as the sample and the other in a different configuration; e.g., eraser on top of car/eraser next to car, block on top of eraser/block in front of eraser, red block on top of blue block/red block next to blue block, etc.

Phase 1b: Nonidentical objects

Sample: randomly select a wide variety of objects within the spatial relation being taught; e.g., an eraser on top of a car, a block on top of an eraser, a spoon on top of a block, etc.
Comparisons: using object pairs that are *not* identical to the sample or to each other, put one pair in the same configuration as the sample and the other in a different configuration; e.g., sample—eraser on top of car, comparisons—spoon on top of block/pencil next to horse; sample—red block on top of blue block, comparisons—orange on top of yellow/green next to purple; etc.

Potential Remediation:
Create the object pair sample, and teach the student to create an object pair that matches the relation shown, with either (1a) identical objects, or (1b) nonidentical objects.

Phase 2: Responding as a listener to instructions based on spatial relations

- Verbal instruction: "Put [object A] [spatial relation] [object B]." E.g.: "Put [the eraser] [on top of] [the car]".
- Pass criteria: 8 consecutive correct
- Termination criteria: 8 cumulative incorrect

Phase 3: Tacting based on spatial relations

- Verbal instruction: "Where's the [object]?"
- Pass criteria: 8 consecutive correct
- Termination criteria: 8 cumulative incorrect

<u>Phase 3a: Tacting object A in relation to object B</u>

- Instruct the student to place object A in relation to object B (e.g., put the eraser on top of the car)
- Present the trial, asking "Where's [object A]?" (e.g., after asking the student to put the eraser on top of the car, ask, "where's the eraser?")

<u>Phase 3b: Tacting object B in relation to object A</u>

- Instruct the student to place object A in relation to object B (e.g., put the eraser on top of the car)
- Present the trial, asking "Where's [object B]?" (e.g., after asking the student to put the eraser on top of the car, ask, "where's the car?")

<u>Phase 3c: Tacting object A/B in random rotation</u>

- Instruct the student to place place object A in relation to object B (e.g., put the eraser on top of the car)
- Present the trial, randomly alternating between asking "Where's [object B]?" and "Where's [object A]?"

<u>Phase 3d: Tacting objects based on the relation specified</u>

- Instruct the student to place place object A in relation to object B (e.g., put the eraser on top of the car)
- Present the trial, randomly alternating between asking "Which one is [relation x]?" and "Which one is [relation y]?" (e.g., after asking the student to put the eraser on top of the car, ask, "which one is on top?" or "which one is under?")

Possible remediation, Phase 2-3d: Return to previous phase and ensure fluency and flexibility with different object pairs.

Extension: Manding

In order to teach manding in accordance with spatial relations, the relevant motivating operations must be contrived. This can be done in both teaching and more naturalistic contexts for the following responses:

- Mand for items to be placed in accordance with a relation (e.g., ask for an item to be put on top/under)
- Mand for items based on their relation to other items (e.g. ask for the item that is on top/under)

Some ideas for contriving motivating operations that require a student to mand in accordance with spatial relations are:

- Place a variety of edibles or other small reinforcers in positions next to/on top of/under/etc. various other things, for example on shelves. The student's task is to ask for what s/he wants, without saying its name, just saying where the item is located.
- Create a matching game using shelving or other means of placing objects in various positions. The task will be for the student to direct the teacher to place a matching object in a particular location based on its relation to something else (e.g., if one shelf contained a car and the shelf above it contained a block, and the teacher had to place a matching block, the correct response would be "put it above the car") or for the student to complete a lotto board by asking for items based on where they are in relation to something else (e.g., "give me the one that is above the car").
- In natural environment training, plan activities that require getting or putting things away (e.g. cooking projects, grocery shopping, putting away groceries), and play a game in which the student needs to tell the teacher where to put an item or what item to get without using its name, just saying where it is in relation to something else.

Reference: Barnard, J.C. & Garofalo, A. (2004). *Where am I? An analysis of preposition use and self-reporting.* Paper presented at the annual meeting of the Association for Behavior Analysis: International, Boston, MA.

Program: Spatial Relations—Nonarbitrary

1. Matching
    - 1.a. Train relations with identical objects as sample/comparisons ("find the right one"): *criteria=8 consecutive correct across both relations*
    - 1.b. Train relations with nonidentical objects as sample/comparisons ("find the right one"): *criteria=8 consecutive correct across both relations*
    - 1.c. Test relations with novel stimulus sets: *criteria=8 consecutive correct across both relations*
2. Listener Responding
    - 2.a. Train relations with a variety of object pairs ("Put [object A] [spatial relation X/Y] [object B]") *criteria=8 consecutive correct across both relations*
    - 2.b. Test relations with novel stimulus sets: *criteria=8 consecutive correct across both relations*
3. Tacting following listener responding ("Where's [object A/B]?") *criteria=8 consecutive correct in test with novel object pairs, across both relations*
    - 3.a. Tact object A in relation to object B; train, then test with novel object pairs
    - 3.b. Tact object B in relation to object A; train, then test with novel object pairs
    - 3.c. Tact objects A/B in random rotation; train, then test with novel object pairs
    - 3.d. Tact objects based on relation specified ("Which one is [relation x/y]?"; train, then test with novel object pairs

Date	Relation X:								Relation Y:								Test X:		Test Y:	
	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -	+ -
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Data Collection Instructions: Highlight current step of program. Fill in targets. Circle correct/incorrect each trial presentation; score right to left and top to bottom, using as many rows as needed. Do not score trials within a correction procedures. Fill in date for each teaching session on first row used for session. End session after either 25 trials total, 8 cumulative incorrect, reaching pass criteria for that step, or based on student motivation. At end of each teaching session highlight trials indicating pass criteria (if reached).

Class Inclusion/Hierarchy: Nonarbitrary Relations
Tabletop Screening Protocols

Screening should be conducted as a teaching type session, with interspersal of non-targeted questions as needed to maintain motivation, and reinforcement as appropriate for the student's plans/needs.

1. Simple tacting

- Select one exemplar of each stimulus item. Shuffle all stimulus cards together. For each stimulus to be used, hold up the card, or point to the card on the table, and ask "What is this?"
- Score first trial for each stimulus item.
- Provide praise/reinforcement for correct responses.
- If any items are not correctly tacted, provide corrective feedback, and repeat the SD. Set aside.
- Return to any incorrectly tacted items at the end of the session. If correctly tacted, repeat tact trial in next session; if retained then keep in stimulus set, but if not retained set aside.
- Student must get 100% correct responding on all stimuli to be used to continue with those stimuli.

2. Yes/No tacting

- Select one exemplar of each stimulus item. Shuffle all stimulus cards together. Randomly select 20 stimulus items to be used.
- Randomize presentation of "yes" and "no" tact trials.
- For each trial, hold up or point to the card on the table, and ask "Is this a [stimulus name]" or "Is this a [not stimulus name, but other name within category]". For example, if the stimulus is a cat, ask either, "Is this a cat?" or "Is this a dog?"
- Provide praise/reinforcement for correct responses.
- Provide corrective feedback for incorrect responses.
- Terminate following 10 "yes" and 10 "no" trial types.
- Student must get 19/20 responses correct to continue.

3. Category tacting

Prior to starting, ensure the student can respond to the contextual cue of "category". Select one exemplar of each stimulus item. Shuffle all stimulus cards together. Tell the student, "now I am going to ask you to tell me the category each of these belongs to. For example, this [hold up a stimulus item] is a type of [name the category], so if I ask you 'What category is this?' you would answer [category]. Let's try it— 'What category is this?'". If the student does not respond correctly, terminate screening.

- For each stimulus to be used, hold up the card, or point to the card on the table, and ask "What category is this?"
- Score first trial for each stimulus item.
- Provide praise/reinforcement for correct responses.

- If any category/items are not correctly tacted, provide corrective feedback, and repeat the SD. Set aside.
- Return to any incorrectly tacted items at the end of the session. If correctly tacted, repeat tact trial in next session; if retained then keep in stimulus set, but if not retained set aside.
- Student must get 100% correct responding on all stimuli to be used to continue with those stimuli.

4. Quantity tacting

- Randomize presentation of quantities of stimuli from 1-10, with different stimuli used for each trial.
- Set out a quantity of stimuli. Ask the student, "How many [stimuli] are there?"
- Provide praise/reinforcement for correct responses.
- If any quantity is not correctly tacted, provide corrective feedback, and repeat the SD.
- Return to any incorrectly tacted quantity with new stimuli at the end of the session. If correctly tacted, repeat tact trial in next session; if retained then continue, but if not, terminate screening.
- Student must be able to tact quantities to 10 with first trial correct responding in order to continue.

5. Nonarbitrary Relational Tacting: More/Less

- Using the stimulus selection cue cards to randomize selection, set out two sets of stimuli.
- Randomize presentation of four trial types:
  - Are there more [stimuli1] or [stimuli2]?
  - Are there less [stimuli1] or [stimuli2]?
  - Are there more [stimuli2] or [stimuli1]?
  - Are there less [stimuli2] or [stimuli1]?
- Provide praise/reinforcement for correct responses.
- If any relation is not correctly tacted, provide corrective feedback, and repeat the SD.
- Terminate following 20 total trial presentations (5 per type)
- Student must get 19/20 responses correct to continue.

Class Inclusion/Hierarchy: Nonarbitrary Relations
Trial Type Cues: Class Inclusion

Are there more [category] or more [stimulus1]?	Are there more [category] or more [stimulus2]?
Are there less [category] or less [stimulus1]?	Are there less [category] or less [stimulus2]?
Are there more [stimulus1] or more [category]?	Are there more [stimulus2] or more [category]?
Are there less [stimulus1] or less [category]?	Are there less [stimulus2] or less [category]?
Which has more: [stimulus1] or [category]?	Which has more: [stimulus2] or [category]?
Which has more: [category] or [stimulus1]?	Which has more: [category] or [stimulus1]?
Do we have more [category] or more [stimulus1]?	Do we have more [category] or more [stimulus2]?
Do we have more [stimulus1] or more [category]?	Do we have more [stimulus2] or more [category]?
Do we have less [stimulus1] or less [category]?	Do we have less [stimulus2] or less [category]?
Do we have less [category] or less [stimulus1]?	Do we have less [category] or less [stimulus2]?

Class Inclusion/Hierarchy: Nonarbitrary Relations
Trial Type Cues: Interspersal

stact: “what are these?” [stimulus1]	stact: “what are these?” [stimulus2]
qtact: “how many [stimulus1] are there?”	qtact: “how many [stimulus2] are there?”
rtact: “are there more [stimulus1] or [stimulus2]?”	rtact: “are there more [stimulus2] or [stimulus1]?”
rtact: “are there less [stimulus1] or [stimulus2]?”	rtact: “are there less [stimulus2] or [stimulus1]?”
ctact: “what category are these?” [stimulus1]	ctact: “what category are these?” [stimulus2]
srec: “point to the [stimulus1]”	srec: “point to the [stimulus2]”
qrec: “point to the one with [quantity-stimulus1]”	qrec: “point to the one with [quantity-stimulus2]”
RFFC: which one... mastered feature or function related to stimulus 1 only (e.g. animal sound, color, sit on, etc.)	RFFC: which one... mastered feature or function related to stimulus 2 only (e.g. animal sound, color, sit on, etc.)
qtact: “how many [stimulus1] do you see?”	qtact: “how many [stimulus2] do you see?”
rtact: “do you see more [stimulus1] or [stimulus2]?”	rtact: “do you see more [stimulus2] or [stimulus1]?”

Class Inclusion/Hierarchy: Nonarbitrary Relations
Stimulus Set Selection Cues

2 cats 4 dogs	2 dogs 4 cats
3 cats 6 pigs	3 pigs 6 cats
2 cats 5 horses	2 horses 5 cats
4 cats 6 cows	4 cows 6 cats
3 cats 5 sheep	5 sheep 3 cats
3 dogs 6 pigs	2 pigs 6 dogs
2 dogs 5 horses	3 horses 5 dogs
4 dogs 6 cows	4 cows 6 dogs
2 dogs 4 sheep	2 sheep 4 dogs
2 pigs 4 horses	2 horses 4 pigs
3 pigs 5 cows	3 cows 5 pigs
4 pigs 6 sheep	4 sheep 6 pigs
3 horses 6 cows	3 cows 6 horses
2 horses 5 sheep	2 sheep 4 horses
3 cows 6 sheep	2 sheep 5 cows

2 apples 4 oranges	2 oranges 4 apples
3 apples 6 bananas	3 bananas 6 apples
2 apples 5 pears	2 pears 5 apples
4 apples 6 strawberries	4 strawberries 6 apples
3 apples 5 lemons	5 lemons 3 apples
3 oranges 6 bananas	2 bananas 6 oranges
2 oranges 5 pears	3 pears 5 oranges

4 oranges 6 strawberries	4 strawberries 6 oranges
2 oranges 4 lemons	2 lemons 4 oranges
2 bananas 4 pears	2 pears 4 bananas
3 bananas 5 strawberries	3 strawberries 5 bananas
4 bananas 6 lemons	4 lemons 6 bananas
3 pears 6 strawberries	3 strawberries 6 pears
2 pears 5 lemons	2 lemons 4 pears
3 strawberries 6 lemons	2 lemons 5 strawberries

2 dresses 4 shirts	2 shirts 4 dresses
3 dresses 6 pants	3 pants 6 dresses
2 dresses 5 skirts	2 skirts 5 dresses
4 dresses 6 jackets	4 jackets 6 dresses
3 dresses 5 socks	5 socks 3 dresses
3 shirts 6 pants	2 pants 6 shirts
2 shirts 5 skirts	3 skirts 5 shirts
4 shirts 6 jackets	4 jackets 6 shirts
2 shirts 4 socks	2 socks 4 shirts
2 pants 4 skirts	2 skirts 4 pants
3 pants 5 jackets	3 jackets 5 pants
4 pants 6 socks	4 socks 6 pants
3 skirts 6 jackets	3 jackets 6 skirts
2 skirts 5 socks	2 socks 4 skirts
3 jackets 6 socks	2 socks 5 jackets

2 cars 4 motorcycles	2 motorcycles 4 cars
3 cars 6 busses	3 busses 6 cars
2 cars 5 trucks	2 trucks 5 cars
4 cars 6 fire engines	4 fire engines 6 cars
3 cars 5 tractors	5 tractors 3 cars
3 motorcycles 6 busses	2 busses 6 motorcycles
2 motorcycles 5 trucks	3 trucks 5 motorcycles
4 motorcycles 6 fire engines	4 fire engines 6 motorcycles
2 motorcycles 4 tractors	2 tractors 4 motorcycles
2 busses 4 trucks	2 trucks 4 busses
3 busses 5 fire engines	3 fire engines 5 busses
4 busses 6 tractors	4 tractors 6 busses
3 trucks 6 fire engines	3 fire engines 6 trucks
2 trucks 5 tractors	2 tractors 4 trucks
3 fire engines 6 tractors	2 tractors 5 fire engines

Class Inclusion/Hierarchy: Nonarbitrary Relations
Assessment and Training Protocol

Materials (see attached):

- pictures of animals, fruits, vehicles, clothing
- cue card sets for stimulus selection
- cue card sets for mixing trials: quantity, nonarbitrary more/less, mastered FFC, class inclusion (maximum of 40 trials, ratio of 1:1 mastered to class inclusion)
- training boxes with one large box containing two smaller boxes (clear plastic), dry erase marker
- data sheets
- reinforcement systems as individualized per student

Prerequisite Skills:

Student must be able to (see screening protocol):

- demonstrate combinatorial entailment in a frame of coordination with familiar stimuli (TARPA SAME AV2i with real life stimulus sets 1 and 2)
- tact all pictures of items
- tact using yes/no
- tact the category of all items
- tact the quantity of items from 1-10
- tact the nonarbitrary relation of two sets of items as being "more" or "less"

Baseline and Generalization Assessment:

Shuffle each set of cue cards (4 sets for stimulus selection, separated by category; 1 set for trial selection consisting of 8 class inclusion trials [one of each trial type] + 8 interspersal trials).

1. Have the student select a card for stimuli; lay out stimuli accordingly (e.g., 2 cats, 4 horses).
2. Select a card for the trial type.
3. Present trial SD.
4. Provide nonspecific praise/noncontingent reinforcement for each trial (e.g., "you're working really hard!" "I like how you're paying attention"); reinforce participation on schedule as determined by student behavior plan or teacher recommendation.
5. Record responses to class inclusion questions per trial type.
6. If non-class inclusion questions are answered incorrectly, make note; all non-class inclusion questions should be mastered as assessed during screening.
7. Remove the stimulus sets, rotate to a new category for stimulus selection, and repeat.
8. Terminate session after 8 class inclusion questions in total.

Intervention Phase 1—Errorless Teaching:
Separate out animal pictures and stimulus selection cards for use during intervention; only animals will be used. For trial cards, use one set, containing one of each class inclusion trial type and an equal number of interspersal questions of varying trial types. Shuffle each set of cue cards (stimulus selection, trial mixing).

Place the training boxes in front of the student—one large clear plastic box for the category and two clear smaller plastic boxes for the stimulus types. State and point to the boxes: "This big box is for the category. What category do these belong to? [point to all the stimulus pictures]" [Student should say "animals"] "That's right. Let's write the category on the box." [Teacher or student (depending on student preference) should write "animals" on the box]. "These two smaller boxes are for the different animals. The small boxes will go inside the animal category box."

1. Have the student select a card for stimuli; teacher should select a trial type card for the trial. The teacher or student (depending on student preference) should **write** the names of the stimuli on each of the boxes (e.g. pig on one box and dog on another box), using dry erase marker.
2. Tell the student to put the stimuli in the appropriate boxes, stating the names of the stimuli, e.g. "Put the [stimulus 1/2] in the small [stimulus 1/2] box, and the [stimulus 1/2] in the small [stimulus 1/2] box". Once the stimuli are in the appropriate boxes, state "Great. [[stimulus 1/2]] and [stimulus 1/2] are types of animals, they belong to the animal category, so they all go inside the big animal category box." Student should place both boxes inside the larger box.
3. In the same order as the trial type card, tell the student to identify the stimulus box and the category box, e.g. if the trial type is more [stimulus2] or more [category], then state "show me the [stimulus2] box". Once the student correctly picks up or points to the stimulus2 box, state "show me the animal category box".
4. If the student makes an error in selecting the animal box (e.g. picks up the other stimulus box), demonstrate the correct response by picking up the animal box and stating "These all belong to the animal category. This is the animal category box." Restate "show me the animal category box," and repeat until student is correct.
5. Present trial SD **while picking up** each of the relevant boxes as you present the SD.
6. Provide specific praise and feedback for all correct responses, **picking up the boxes** (e.g., "That's right! There are 4 horses [pick up box]," "That's right, there are more animals [pick up box] than dogs [pick up box]!/ there are less dogs than animals!")
7. For incorrect responses to "more" class inclusion questions, provide corrective feedback as follows:
   a) **Repeat the requirement** to identify the stimulus and animal boxes, as in step 3/4.
   b) State, **while picking up the boxes**, ""That's right. [stimulus1/2] and [stimulus 1/2] are types of animals, so they all go inside the big animal category box. They all belong to the animal category but only these are [stimulus1/2], so there are more animals in the animal category box than there are [stimulus1/2] in the [stimulus1/2] box.
   c) Repeat the trial SD as in step 5.
   d) Provide specific praise and reinforcement for correct responding.

   e) Select a new set of stimuli and repeat the same trial type (specific type of "more" class inclusion) until correct first trial response with new stimulus set; intersperse a distracter trial, and repeat until there are a total of **three consecutive correct** first trial responses with a new stimulus set.
8. For incorrect responses to "less" class inclusion questions, provide corrective feedback as follows:
   a) **Repeat the requirement** to identify the stimulus and animal boxes, as in step 3/4.
   b) State, **while picking up the boxes**, "That's right. [stimulus1/2] and [stimulus 1/2] are types of animals, so they all go inside the big animal category box. They all belong to the animal category but only these are [stimulus1/2], so there are less [stimulus 1/2] in the [stimulus 1/2] box than there are animals in the animal category box."
   c) Repeat the trial SD as in step 5.
   d) Provide specific praise and reinforcement for correct responding.
   e) Select a new set of stimuli and repeat the same trial type (specific type of "less" class inclusion) until correct first trial response with new stimulus set; intersperse a distracter trial, and repeat until there are a total of **three consecutive correct** first trial responses with a new stimulus set.
9. Record first-trial (i.e first with stimulus set) responses to class inclusion questions per trial type; do not record responses during correction.
10. If non-class inclusion questions are answered incorrectly, make note; all non-class inclusion questions should be mastered as assessed during screening.
11. Terminate session after a correct response has been given on each of the 8 class inclusion questions.

Move to next phase once student is 100% correct in selecting appropriate boxes and achieves 8/8 first trial correct with class inclusion questions.

Intervention Phase 2:
Use the same stimulus type and trial type card setup as previously, but use 3 sets of trial cards (8, 8, and 4 class inclusion questions, one of each type per set, mixed with equal numbers of interspersal questions). In this phase, verbal reference to the size of the boxes and the pre-trial requirement to identify the boxes by type/category are eliminated.

1. Have the student select a card for stimuli; teacher should select a trial type card for the trial. The teacher or student (depending on student preference) should **write** the names of the stimuli on each of the boxes (e.g. pig on one box and dog on another box), using dry erase marker.
2. Tell the student to put the stimuli in the appropriate boxes, stating the names of the stimuli, e.g. "Put the pigs in the pig box, and the dogs in the dog box". Once the stimuli are in the appropriate boxes, state "Now put all of them inside the animal category box." Student should place both boxes inside the larger box.
3. Present trial SD (do not pick up the boxes).
4. Provide specific praise and feedback for all correct responses, referencing and picking up the boxes and stating that they are all belong to the animal category, but only the stimulus type

is the stimulus, for class inclusion trials, but without the verbal reference to the boxes (e.g., "That's right! There are 4 horses [pick up box],""That's right, there are more animals [pick up box] than dogs [pick up box]!/ there are less dogs than animals!")

5. For incorrect responses to "more" class inclusion questions, provide corrective feedback as follows:
   a) Present the SD to identify the stimulus and animal boxes, as in step 3/4 of the errorless teaching phase.
   b) State, **while picking up the boxes**, "they all belong to the animal category but only these are [stimulus1/2], so there are more animals than there are [stimulus1/2.
   c) Repeat the trial SD (without picking up the boxes).
   d) Provide specific praise and reinforcement for correct responding.
   e) Select a new set of stimuli and repeat the same trial type (specific type of "more" class inclusion) until correct first trial response with new stimulus set; intersperse a distracter trial, and repeat until there are a total of **three consecutive correct** first trial responses with a new stimulus set.
8. For incorrect responses to "less" class inclusion questions, provide corrective feedback as follows:
   a) Repeat the requirement to identify the stimulus and animal boxes, as in step 3/4 of the errorless teaching phase.
   b) State, **while picking up the boxes**, "they all belong to the animal category but only these are [stimulus1/2], so there are less [stimulus 1/2] than there are animals"
   c) Repeat the trial SD (without picking up the boxes).
   d) Provide specific praise and reinforcement for correct responding.
   e) Select a new set of stimuli and repeat the same trial type (specific type of "less" class inclusion) until correct first trial response with new stimulus set; intersperse a distracter trial, and repeat until there are a total of **three consecutive correct** first trial responses with a new stimulus set.
9. Record first-trial (i.e first with stimulus set) responses to class inclusion questions per trial type; do not record responses during correction.
10. If non-class inclusion questions are answered incorrectly, make note; all non-class inclusion questions should be mastered as assessed during screening.
11. Terminate session after a correct response has been given on each of the 8 class inclusion questions.

Move to next phase once student achieves 8/8 first trial correct with class inclusion questions.

Generalization Phase 1: Animals
Using only the animal cards, follow the procedure as above for baseline/generalization (i.e. do not use the boxes or provide feedback).

If responses do not generalize without the boxes, return to Intervention Phase 2.

Generalization Phase 2: Novel categories
Follow the procedure as in baseline, with all categories ***except animals*** represented.

If responses do not generalize to novel stimuli, return to Intervention Phase 1 with a new category.

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Derived Relational Responding: Literature Review

Ming, S., Moran, L., & Stewart, I. (2014). Derived relational responding and generative language: Applications and future directions for teaching individuals with autism spectrum disorders. *European Journal of Behavior Analysis*, *15*(2), 199-224. doi: 10.1080/15021149.2014.11434722

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Derived Relational Responding and Generative Language: Applications and Future Directions for Teaching Individuals With Autism Spectrum Disorders

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While many individuals with autism spectrum disorders (ASD) develop a flexible, generative language repertoire following intensive early intervention, many others continue to require intensive teaching and exhibit language repertoires that could be characterized as rigid or rote. Research in the area of derived stimulus relations shows promise for developing teaching procedures for students with ASD that focus on remediating these deficits and establishing generative verbal behavior. We provide an explanation of the theoretical background of derived stimulus relations research, with an emphasis on Relational Frame Theory, and review studies that (i) demonstrate the establishment of derived relational responding when such skills are absent, and (ii) use existing derived relational responding skills to teach educationally relevant skills to individuals with ASD or other developmental disabilities. Based on this review, we give a number of recommendations for teaching and curricular sequencing principles, assessment strategies, and areas for future research.

Key words: relational frame theory, equivalence, derived relational responding, autism, language intervention

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Impairments in communication are core diagnostic features of autism spectrum disorders (ASD). As such, a focus on teaching language skills has been identified as one of the critical components of effective intervention programs for children with ASD (e.g., National Research Council, 2001), and behavior analytic approaches to the treatment of ASD typically place an emphasis on the analysis and development of such skills (e.g., see Sundberg & Michael, 2001). However, despite decades of research that have established the effectiveness of applied behavior analysis as an intervention for ASD (e.g., see Makrygianni & Reed, 2010; National Autism Center, 2009), and the marked success of programs that have resulted in many children progressing to the point of age-typical language and academic skills (e.g., Butter, Mulick, & Metz, 2006; Lovaas, 1987; Perry, Cohen, & DeCarlo, 1995), a substantial number of children continue to require ongoing intensive teaching to learn new vocabulary and concepts, and their language skills remain "rote". It appears that these children fail to develop generative language—the ability to produce and understand sentences never heard or said before (Greer & Ross, 2008; Malott, 2003).

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This suggests that linguistic generativity is critically important but that behavior analysis lacks an effective understanding of this phenomenon. Furthermore, a relatively recent quote from Richard Malott in which he refers to linguistic generativity or, as he calls it, productivity, as the "greatest intellectual challenge to the field of behavior analysis" (2003, p. 11) would seem to support both these conclusions. However, while the first conclusion is still as true today as ever, there is now hope that behavior analytic science has begun to gain a better understanding of generative language. Developments in the area of derived stimulus relations research seem promising in this respect. This area of research, with its emphasis on the emergence of novel, untrained responses, has begun to identify a promising set of procedures for teaching generative verbal behavior (e.g., Rehfeldt & Barnes-Holmes, 2009). The purpose of the current paper is to provide a theoretical background to derived stimulus relations, mainly using Relational Frame Theory (RFT; Hayes, Barnes-Holmes & Roche, 2001), and also to review research in this area that is applicable to teaching language to individuals with ASD or other developmental disabilities.

Derived Equivalence

The most prominent empirical example of derived relational responding is stimulus equivalence, which was first demonstrated in Sidman's now classic 1971 study that involved teaching reading to a young man with a learning disability. At the outset of the study, for a particular set of stimuli, the participant could emit spoken words (A) given pictures (B), and could select pictures (B) given spoken words (A); and in the initial part of the study he was taught to select printed words (C) given spoken words (A). However, he subsequently showed several additional untaught or derived performances, including saying appropriate spoken words (A) given printed words (C), matching pictures (B) to printed words (C), and matching printed words (C) to pictures (B). As such, he was responding as if particular sets of spoken words, pictures and printed words were the same as or equivalent to each other and thus Sidman termed this pattern of responding *stimulus equivalence.*

Based on these results and subsequent empirical data, Sidman suggested that stimulus equivalence is defined by three emergent relations, namely, *reflexivity,* (A=A), *symmetry* (if A=B then B=A) and *transitivity* (if A=B and B=C, then A=C). An additional feature of stimulus equivalence known as *transfer of functions* has also been demonstrated (e.g., Dougher, Augustson, Markham, Greenway & Wulfert, 1994) whereby the behavioral functions of a given stimulus (e.g., discriminative [e.g., Dymond & Barnes, 1995] or eliciting [e.g., Dougher, et al. 1994]) transfer, without additional training, to other stimuli that participate in a relation of equivalence with the first stimulus. For example, if a child is taught to derive a relation of equivalence between the spoken and written words "cat" and an actual cat, then some of the stimulus functions of the latter may transfer to each of the two former such that, for example, the written or spoken word "cat" may now evoke an image of a small furry animal.

The phenomenon of responding in accordance with stimulus equivalence has generated interest and debate within behavior analysis for a number of reasons. It is not predicted by traditional operant theory, in that the symmetrical and transitive response relations do not have the history of reinforcement that would be needed to establish conditional discriminations (Barnes, 1994). In addition, it has practical advantages since the fact that not all relations need be taught directly means efficiencies in terms of time and effort. Perhaps most importantly, it seems closely linked with human language. For example, in terms of its characteristics, it possesses several key features that are language-like including bi-directionality and generativity (Fields, Verhave & Fath, 1984).

Furthermore, a range of empirical evidence supports the link between stimulus equivalence and language. One line of evidence has come from the contrast between verbal and non-verbal organisms in ability to show derived equivalence relations. In typically developing humans, derived equivalence relations develop in parallel with language ability (e.g., Lipkens, Hayes & Hayes, 1993) while humans with absent or delayed language repertoires tend to be unable to respond in accordance with equivalence (e.g., Devany, Hayes & Nelson, 1986) and the evidence for derived equivalence in non-humans is scant and at best disputable (e.g., Dugdale & Lowe, 2000; though see also Schusterman & Kastak, 1993). The link between equivalence and language is also supported by the results of neuroscientific research demonstrating that brain activity measured during derived relational responding tasks resembles that seen during language performance (e.g., Dickins et al. 2001; Ogawa, Yamazaki, Ueno, Cheng & Iriki, 2010).

Relational Frame Theory

The empirical link between derived relational responding (such as is seen in stimulus equivalence) and language is particularly intriguing and exciting for behavior analysts. As such, a number of theories have been advanced in an attempt to explain the link (e.g., Hayes, Barnes-Holmes & Roche, 2001; Horne & Lowe, 1996; Lowenkron, 1998; Sidman, 1994, 2000). A wealth of empirical evidence has accumulated based on the account provided by Relational Frame Theory (RFT; Barnes-Holmes, Y., Barnes-Holmes, D., Roche & Smeets, 2001a, 2001b; Dymond & Roche, 2013; Hayes, 1991, 1992; Hayes et al., 2001) and accordingly, we will largely use this approach as the theoretical background to our review.

Relational Frame Theory suggests that the empirical association between derived equivalence and language comes about because they are essentially the same phenomenon, namely *generalized contextually controlled arbitrarily applicable relational responding* or more simply, *relational framing*. Many species, including humans, demonstrate generalized relational responding based on physical properties of the relata (e.g., picking an object that is physically the same as another object, as in identity matching, or picking something that is physically larger or smaller than something else), referred to as non-arbitrary relational responding (e.g., Hayes, Fox, Gifford, Wilson, Barnes-Holmes & Healy, 2001; Reese, 1968; Stewart & McElwee, 2009). However, RFT posits a further type of generalized relational responding that can be learned in which the relational response is determined by contextual cues independent of the properties of the related objects. For example, if I am told that X is the same as Y and Y is the same as Z, then I can derive that Y is the same as X, Z is the same as Y, X is the same as Z and Z is the same as X. In this case, the pattern of derived relational responding is not based on the actual properties of the letters, but on the contextual cue 'same as', which was established to function as such in the course of my learning history as we will describe further below. RFT theorists argue that the reinforcement history that has led to this type of sameness (or *coordination*) relational responding is what underlies an organism's ability to respond in accordance with a pattern of stimulus equivalence. From the RFT perspective, however, sameness is only one type of derived relational pattern. Over the last two decades, RFT researchers have provided empirical evidence for a variety of other patterns of derived relations in addition to sameness including *distinction* (e.g., Roche & Barnes, 1997), *comparison* (e.g., Berens & Hayes, 2007), *opposition* (Barnes-Holmes, Barnes-Holmes, Smeets, Strand, & Friman, 2004), *analogy* (e.g., Persicke, Tarbox, Ranick & St. Clair, 2012; Stewart, Barnes-Holmes, Roche & Smeets, 2004), *temporality* (O'Hora, Barnes-Holmes, Roche, & Smeets (2004) and *deixis* (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004) and RFT proponents argue that this variety of relational patterns or frames underlies the diversity, complexity and generativity of human language. Further research is of course needed to fully explore this hypothesis and to gauge the patterns of development of the diverse frames involved as well as their interaction, but RFT research has at least started to make useful inroads in this respect (see Dymond & Roche, 2013, for an overview of recent research).

Two characteristics of derived arbitrarily applicable relational responding or relational framing that seem particularly important from the current perspective are that it is extremely generative and that it can be trained. Evidence for the generativity of this behavior has been provided by many of the RFT studies that have appeared in the literature thus far, though a few in particular deliberately highlight this characteristic (e.g., O'Hora, Barnes-Holmes, Roche, & Smeets, 2004; Stewart, et al., 2004; Wulfert & Hayes, 1988). For example, Stewart et al. (2004) used an RFT-based procedure known as the relational evaluation procedure (REP) to establish abstract shapes as contextual cues for SAME and DIFFERENT relational responding and for TRUE and FALSE responses, respectively, and then employed these cues both to model analogical reasoning as the relating of derived relations between derived relations as well as to demonstrate that an in-principle infinite number of new analogical relations was possible based on this technique.

As an operant, relational framing itself is learned and can be trained. That is, in addition to using relevant stimulus arrangements to establish contextual control over new conditional discriminations (and thereby capitalize on the wealth of emergent relations that result), as described above, the ability to derive relations of various types can be trained when such responses do not emerge following appropriately arranged conditional discrimination training. RFT proponents have argued that framing is learned naturally by typically developing children via everyday language interactions during which they are exposed to contingencies that establish these response patterns (e.g., Lipkens et al., 1993; Luciano, Gómez & Rodríguez, 2007). From this perspective, caregivers provide children with multiple exemplars for appropriate responding in accordance with particular stimulus relations. Consider, for example, the very early history of training responsible for establishing sameness (coordination) relations between a word and an object. Caregivers will often utter the name of an object in the presence of an infant and then reinforce any orienting response that occurs towards the particular object (hear name A → look at object B). They will also often present an object to the infant and then model the name of it, and reinforce echoic responding in the presence of that object (see object B → hear and say name A). RFT suggests that after a sufficient number of name-to-object and object-to-name exemplars have been taught, the generalized operant of symmetrical object-name responding is established. Effectively, the multiple-exemplar bi-directional training establishes particular contextual cues as discriminative for symmetrical responding. For instance, imagine that a child with such a history is told, "This is a teddy." Contextual cues, including the word "is" and other aspects of the naming context (such as the presence of the caregiver, pointing to objects, and so on), will now be discriminative for symmetrical responding between the name and the object. Thus, without any additional training, the child will now not only answer, "teddy" when presented with the teddy and asked, "What is this?" (object B → name A), but will also derive the response of pointing to the teddy when asked, "Where is the teddy?" (name A → object B).

Relational frame theory argues that such multiple exemplar training (MET) also enables responding in accordance with a pattern of stimulus equivalence. Similar to the way in which a child can learn symmetrical responding through exposure to the socio-verbal environment they may also learn more complex relations involving three or more stimuli.. When first learning sight words, for instance, an individual might be explicitly taught that a picture (A), an auditory stimulus (B) and a textual stimulus (C) "go together" so that they are mutually substitutable for each other in certain contexts such that the selection of any one of the three in the presence of either of the others will produce reinforcement. After sufficient exemplars of groupings of three or more mutually substitutable stimuli such as this, the child may begin to derive transitive relations based on being taught two of the symmetrical relations in a novel grouping. For example, having been taught that a picture of a dog (A) should be selected with the spoken word "dog" (B) and that the textual stimulus "dog" (C) should also be selected with the spoken word (B), they may then, without additional reinforcement, choose the picture (A) with the textual stimulus (C) and vice versa.

Hence, relational framing is seen as a generalized or overarching response class generated by a history of reinforcement across multiple exemplars, and once established any stimulus or response event, irrespective of form, may participate in a relational frame. The above example suggests how framing is learned through natural language interactions. However, over the last decade a number of RFT studies have provided empirical demonstrations of the use of MET as a means of deliberately training framing repertoires in young children for whom they are deficit or absent. For example, Barnes-Holmes, Barnes-Holmes, Smeets, Strand & Friman (2004) and Barnes-Holmes, Barnes-Holmes & Smeets (2004) trained repertoires of "more / less" and "opposite" relational framing, respectively, in young children aged between 4 and 6 when they were found to be absent; Luciano et al. (2007) trained a young infant whose age ranged from 15-23 months during the study to respond in accordance with stimulus equivalence; while Berens and Hayes (2007) and Weil, Hayes & Capurro (2011) provided multiple baseline demonstrations of the training of comparative and deictic frames, respectively, in 4-5 year olds.

While there are many different forms or patterns of relational framing from the RFT perspective, they all share three core properties: mutual entailment, combinatorial entailment and transformation of stimulus function. These properties are analogous to those of symmetry, transitivity, and transfer of function, which are found in the case of stimulus equivalence, but they are broader, more generic concepts that can be applied to relations other than sameness or coordination.

Mutual entailment involves learning a relation between two items in one direction (A→B) and then being able to respond in the other direction (B→A) without specific teaching (i.e., deriving the relation). The naming example above demonstrates this for a frame of sameness, while with other types of frames, the relation is derived in accordance with the frame; for example, if A is bigger than B, then B is smaller than A; if A is above B, then B is below A, and so on.

Combinatorial entailment involves combining two stimulus relations (trained or derived) to get a third: if A→B and C→B, then A→C and C→A. For example, having learned that a bat goes with a ball, and that a glove goes with a ball, a child may then put the bat and the glove together without having been taught to do so. As in the examples for mutual entailment, the relation is derived in accordance with the frame: in a frame of opposition, for example, if A (e.g., "Hot") is the opposite of B (e.g., "Cold"), and C (e.g., "High temperature") is the opposite of B, then A "Hot") and C ("High temperature") are the same; in a frame of comparison, if a euro is worth more than a dollar, and a dollar is worth more than a ruble, then a euro is worth more than a ruble and a ruble is worth less than a euro; and so on.

The third property of relational framing, transformation of function, is demonstrated when the psychological function of a stimulus is changed or transformed in accordance with the relation between that stimulus and another stimulus in a relational frame. This feature is critically important, as it involves behavior being changed via relational framing. For example, imagine that a child has already learned that she can purchase an item in the store with a particular coin and is then told that another, previously unseen coin is worth more than the first one. A child who has a sufficient repertoire of comparative relational framing will be able to respond in accordance with this relation and the reinforcing function of the second coin will be transformed so that it becomes more appetitive than the first. Hence, if given a choice, the child will likely ask for the second, novel coin, in preference to the first, despite having only received reinforcement in the presence of the first.

Thus, from the current perspective, derived relational responding, with its properties of mutual and combinatorial entailment and transformation of functions is a key process involved in learning generative language. The purpose of this review is to examine two primary areas of research: a) studies that have established derived relational responding skills when absent, and b) studies that have used the derived relational responding paradigm to efficiently expand various behavioral repertoires. Rehfeldt (2011) recently reviewed the literature on relational responding as published in the Journal of Applied Behavior Analysis, and made a number of important suggestions for the future of this area of research to which we will also return throughout this review.

We believe that RFT provides a coherent and thorough framework for understanding derived relational responding and how it relates to generative language and accordingly in our introduction we have provided a brief overview of the RFT conception of derived relational responding as relational framing that will allow theoretical direction for our review. At the same time, as well as citing RFT research on derived relations this review will also refer to the work of behavior analytic researchers who adopt theoretical positions on derived relations other than RFT (e.g., Horne & Lowe, 1996), as we recognize the value of their work both in terms of the data that they provide as well as in terms of their contribution to theoretical debate concerning derived relations and language (e.g., Greer & Ross, 2008; ; Luciano, Rodríguez & Mañas, 2009; Miguel, Yang, Finn & Ahearn, 2009). Most importantly we will highlight the benefits of incorporating relational responding into behavioral educational curricula for individuals with developmental disabilities.

Derived Relational Responding: Two Types of Studies

We have now provided the key theoretical and empirical background to the phenomenon of derived relational responding. As described, from an RFT perspective, derived relational responding or relational framing is a generalized or overarching operant response class generated by a history of reinforcement across multiple exemplars, and its development underlies the development of language and complex abilities (e.g., problem solving, planning, reasoning etc.). In the next section we will review studies on derived relational responding that are directly relevant with respect to the application of this phenomenon in the educational arena, and in particular to teaching generative language to young children with ASD (or other developmental delays).

Although many individuals with ASD may have the ability to derive relations, others may not (McLay, Sutherland, Church & Tyler-Merrick, 2013). In fact, one of the core problems for many individuals with ASD or other developmental delays is that their relational framing/derived relational repertoires are either markedly deficient or absent (see, e.g., Devany et al., 1986; McLay et al., 2013). In such cases, establishing derived relational responding skills is critical in order to establish generative verbal behavior. We will therefore review studies that aimed to establish repertoires of derived relational responding from the bottom up, through multiple exemplar training. Since such repertoires are so fundamental to the development of generative language, establishing them using appropriate interventions (e.g., MET) is of critical importance. Empirical work in this area is less advanced than work capitalizing on pre-existing derived relational repertoires; although there is some work establishing such repertoires, it has mainly (though not exclusively) been carried out with typically developing participants. At the same time, the work that has been conducted suggests the potential and promise of such interventions for remediating the absence of linguistic generativity.

On the other hand, many children with ASD do have at least a basic repertoire of derived relational ability, such as responding in accordance with stimulus equivalence/frames of coordination, which has been acquired through exposure to natural socio-verbal contingencies. Though perhaps not as well practiced or advanced as that of typically developing children, this ability nevertheless can be used and built upon in order to expand their repertoire of skills and responses more rapidly and efficiently than would be possible through more conventional training. Many studies of derived relational responding, including the seminal study by Sidman (1971), have capitalized on this type of potentially generative repertoire to rapidly expand the linguistic and behavioral repertories more generally of those with developmental delay. The participants in such studies readily demonstrated derived relational responding once they had acquired the necessary conditional discriminations (i.e., when assessed, they were able to respond in accordance with stimulus equivalence). In other words, their generalized ability to demonstrate derived relational responding appears to have already been established and the interventions described capitalized on this ability. The educational relevance of this approach is significant and it offers substantial benefits, as we will review below.

With respect to both of these areas of need—establishing derived relational responding skills when absent, and capitalizing on existing skills—it is clear that any comprehensive behavior analytic educational program will need to take an approach incorporating functional assessment and appropriate goal setting. That is, practitioners must be able to determine what skills are lacking, and which of those skills might constitute behavioral cusps that would then allow for rapid generalization and additional skill acquisition. We will address this need for functional assessment of existing derived relational responding skills in our concluding discussion of this review.

Establishing Derived Relational Responding Skills

We will first examine the growing body of research showing the establishment of derived relational responding skills. This research is primarily in the applied work based on Relational Frame Theory; other approaches such as Naming theory (Horne & Lowe, 1996) and Verbal Development Theory (Greer & Speckman, 2009) have also contributed to the literature on derived relational responding albeit from a different theoretical position, which we will discuss below. The RFT conceptualization of derived relational responding as a higher order operant behavior outlines a clear learning pathway for these skills. From this point of view, MET in relational responding skills is not only seen as the means by which typical children develop language skills, but also suggests the means of remediation and training of such skills when they are absent. As stated earlier, RFT proposes that there are many different contextually controlled relational patterns of responding. Skills within several different patterns, or *frames,* of derived relational responding have been targeted for remediation in both typically developing young children and individuals with ASD and other developmental disabilities; relational skills trained have included coordination (Luciano et al., 2007; Murphy, Barnes-Holmes & Barnes-Holmes, 2005), comparison (Barnes-Holmes, Y., Barnes-Holmes, D., Smeets, Strand, & Friman, 2004; Berens & Hayes, 2007; Gorham, Barnes Holmes, Barnes-Holmes & Berens, 2009; Murphy & D. Barnes-Holmes, 2010), opposition (Barnes-Holmes, Y., Barnes-Holmes, D., & Smeets, 2004), and *perspective taking* (Rehfeldt, Dillen, Ziomek & Kowalchuk, 2007; Weil et al., 2011). In what follows, we review empirical examples of the training of these frames.

Teaching the frame of coordination. The pattern of derived relational responding that characterizes the classic pattern of stimulus equivalence in which stimuli are "substitutable" for one another is often termed a frame of sameness or coordination within RFT. Across the literature there is a relative paucity of research (with either typically developing or developmentally delayed populations) that looks at remediating absent relational framing skills through explicit training. The frame of coordination is particularly difficult to examine empirically with respect to procedures for training individuals to respond in accordance with this pattern when they do not already readily demonstrate such derived relational responding skills, since these skills appear to develop quite early in typical language development. For example, Lipkens et al., (1993) examined the emergence of the frame of coordination in a young typically developing child (age 16-27 months over the course of the study). He could derive mutually entailed picture-name relations as early as 17 months, and combinatorially entailed name-sound relations by 24 months. Thus, populations that would be expected not to have this skill already are restricted to infants or young toddlers and individuals with significant developmental disabilities. Nevertheless, there are already several studies whose work can be considered relevant to the establishment of coordinate framing—at both mutual entailment (symmetry), and combinatorial entailment (transitivity) levels.

Luciano et al. (2007) assessed and trained a very young child (age 15 months at the outset of the study) who did not initially show receptive symmetry, which was defined as the untrained ability to select a requested object from an array, after that object had previously been labeled (using a nonsense word) by the experimenter. That is, if the experimenter gained the child's attention and then presented an item, saying, "This is [x]", the child was initially unable to later select object [x] from an array. MET in bidirectional object-sound/sound-object relations with 10 different stimuli was then provided. First, an object (A) was presented, and then vocally labeled (B) by the experimenter (i.e., A-B relations), and then (after progressively longer delays) training was provided in the selection of the object from an array (i.e. B-A relations). Following training, the child could show delayed receptive symmetry with novel objects; that is, she could select a specified item from an array (B-A) for a novel item that had been previously (with a delay) shown to her and labeled by the experimenter (A-B). After subsequent training in visual-visual conditional discriminations, she also showed equivalence.

Barnes-Holmes, Barnes-Holmes, Roche and Smeets (2001a, 2001b) examined the development of action-object symmetry in typically developing four- and five-year-olds. While it would be expected that children of this age would have well-established derived relational responding repertoires, these studies utilized a context with which the children were unfamiliar, thus revealing a gap in their relational repertoires that could subsequently be trained. Rather than using a standard match-to-sample context for training relations, the researchers taught the children to select a particular stimulus in the presence of a particular action, or vice versa (e.g., in some experiments, when the experimenter waved, the child selected stimulus A1, while when the experimenter clapped, the child selected stimulus A2; in other experiments, the child was taught to perform the action in the presence of the particular stimulus). Children were then tested for symmetry, by being required to perform the action in the presence of each stimulus item, or vice versa, depending on which had been trained (e.g. clap in the presence of A1 if training had consisted of selecting stimulus A1 when the experimenter clapped). Across all multiple baseline experiments within the studies, the majority of children failed to demonstrate symmetry when first tested; subsequently, multiple exemplar training (e.g., explicitly teaching the action to perform in the presence of the stimulus item) quickly resulted in the demonstration of symmetry with novel stimulus sets across all children.

Murphy et al. (2005) examined the development of transfer of function through equivalence relations. This study was one of several that have focused on training methods involving both derived relational responding (i.e., the key process characterizing verbal behavior from an RFT perspective) with operant behaviors defined as verbal within a Skinnerian perspective (e.g., manding, tacting and intraverbals; see D. Barnes-Holmes, Y. Barnes-Holmes & Cullinan [2000] for a discussion of the synthesis of these two approaches). Murphy et al. (2005) combined derived relations with manding (that is, responses that are reinforced by delivery of a specific consequence, and which are therefore under the control of the establishing operations relevant to that consequence [Michael, 1988, Skinner, 1957]) as a means of facilitating a more flexible manding repertoire. They used a token board game to contrive conditioned establishing operations for two differently colored tokens needed to fill the board. Similar to the use of a picture exchange system for manding, abstract stimuli A1 and A2 were trained to have discriminative functions for manding the two different color tokens respectively. Subsequently, participants were trained in A-B and B-C conditional discriminations, and then tested for their ability to mand using C stimuli (i.e., thus showing transfer of the discriminative functions from A1 and A2 to C1 and C2 respectively, which in this context was termed 'derived manding'). Two participants showed transfer of function immediately. The third, who did not do so, was given MET. After directly training transfer of function (i.e., training him to mand using both A1 and C1 stimuli and A2 and C2 stimuli), a novel set of stimuli was used to repeat mand and conditional discrimination training and test for transfer of function. He again failed and then was trained on that set. After MET with three stimulus sets, the participant showed transfer of function with a fourth novel set.

In a unique recent study, Walsh, Horgan, May, Dymond and Whelan (2014), used a computerized variation on traditional match-to-sample formats, the Relational Completion Procedure (RCP), in which the task was to "drag and drop" the correct comparison stimulus into a blank box next to the sample stimulus. In this study, six of the nine participants (all of whom were diagnosed with ASD) were unable to derive relations between text and picture stimuli in accordance with a frame of coordination following initial conditional discrimination training on baseline (A-B and A-C) relations. These participants were then given MET. "Sham" MET (i.e., training in unrelated conditional discriminations) was given to two of the participants in order to control for possible emergence of derivation following repeated exposure to testing stimuli or time on task and this did not result in the emergence of derived relations on new stimulus sets. However, relevant MET did result in the emergence of derived relations on novel stimulus sets for these two participants as well as a third (with the study ending due to time constraints before the remaining participants could complete MET with multiple stimulus sets).

Establishing frames of coordination among auditory and visual stimuli is clearly critical for language development. Thus far we have considered a number of RFT-based studies that have used MET to train coordinate relations. However, RFT is not the only theoretical approach relevant in this respect. A number of theorists and researchers working outside the RFT paradigm have focused on a similar domain via the concept of *naming*. The latter has been defined as the ability to "acquire both the speaker and listener responses to stimuli as a result of observing stimuli while hearing others say the *names*... without direct instruction in the form of reinforcement or error corrections" (Gilic & Greer, 2011, p 157). Many researchers see naming as a distinctive and fundamental verbal repertoire (e.g., Greer & Keohane, 2004; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Horne & Lowe, 1996). Furthermore, a number of studies have shown the facilitative effect of naming (as well as the inclusion of stimuli that are familiar/nameable/pronounceable or have other discriminative functions) on the demonstration of equivalence (e.g., Eikeseth & Smith, 1992; Fields, Arntzen, Nartey & Ellifsen, 2012; Holth & Arntzen, 1998; Horne, Hughes, & Lowe, 2006; Horne, Lowe, & Harris, 2007; Lowe, Horne, & Hughes, 2005 though see also Luciano et al., 2007, O'Connor, Rafferty, Barnes-Homes, D. & Barnes-Holmes, Y., 2011). In addition, there are now several studies that have examined how MET might be used to establish this repertoire. From an RFT point of view, naming is an example of mutually entailed name-object relations and more broadly of coordinate relations; hence its empirical link with equivalence. While not considered a distinctive repertoire as such, it is nevertheless of critical importance. Hence, in what follows, in the final part of this section on establishing coordinate relations, we will consider studies that have used MET to attempt to establish naming.

Greer et al. (2005) used MET to establish mutually entailed responding in the form of the listener to speaker component of naming (i.e., being able to name an object based on previously being taught to respond as a listener, such as by selecting the object when it is named) in three children with mild developmental delay who at baseline did not have this repertoire. Baseline probes consisted of teaching the child matching responses using discrete trial presentations where the teacher spoke the name of the picture as the child matched (i.e., name-object; A-B training). Once criterion was met for the matching responses, a probe was conducted for the untaught repertoires—pointing, tacting (i.e., responding under the control of a nonverbal stimulus and generalized nonspecific conditioned reinforcers [Skinner, 1957]) with no teacher provided antecedent and tacting after the teacher asked, "What is this?" (referred to as *pure* and *impure* tacting respectively). Specifically, these probes tested for the emergence of derived object-name relations (or B-A relations). During these probes, the participants did not demonstrate derived relational responding (i.e., after learning A-B relations they did not mutually entail B-A relations) and thus they were exposed to MET. During MET, they were taught to respond as listeners (matching and pointing-to) and speakers (pure and impure tacting) to two sets of five pictures (i.e., response topographies were rapidly rotated across the teaching session). As a function of this MET, untaught speaker responses emerged after only matching responses were taught for a third novel set of stimuli, consistent with mutual entailment. Fiorile and Greer (2007) subsequently tested whether pure tact (object-name) instruction alone would lead to naming. The four children who participated had severe language delays, had no repertoire of learning tacts through echoic to tact transfer of stimulus control training procedures nor untrained echoic-to-tact transfer and did not demonstrate naming (either speaker to listener or listener to speaker). Pure tact training alone did not result in a naming repertoire or untrained echoic-to-tact responses for these students. MET was provided across matching, speaker (pure tact) and listener repertoires for a subset of stimuli (the teaching set) and this resulted in untaught response components of naming and the capability to acquire naming after learning pure tacts for subsequent sets of stimuli.

Greer, Stolfi and Pistoljevic (2007) replicated the effects of the previous two studies and also isolated MET as the variable that led to the emergence of naming. In this study they compared singular exemplar instruction (SEI) and MET on the emergence of naming in preschool children who were missing the repertoire. Four participants were taught training sets of pictures using MET, in which matching, speaker and listener responses were systematically rotated during instruction, and four other children were taught the same sets using SEI, in which all topographies (matching, speaker, and listener responses) were taught separately from each other, each in 20-trial sessions. The number of instructional presentations was matched for both groups. Naming emerged for the MET group but not for the SEI group. Subsequently, the SEI participants received MET and naming emerged.

Teaching the frame of comparison. A number of studies have examined training relational responding skills other than coordination or equivalence with typically developing young children. Comparison is likely one of the first relations to develop following coordination (see, e.g., Luciano et al., 2009). There is not yet sufficient empirical evidence to determine in exactly what sequence different frames might emerge; however, once a child has a repertoire of coordinate framing, they will probably have a reasonably well developed vocabulary. This is because, as described earlier, RFT suggests that multiple exemplar training involving explicit bi-directional training with an extensive variety of object-name pairs is needed before the acquisition of coordinate framing. As such, the child will likely have learned to tact a significant number of things, and will also be able to rapidly acquire new tacts through derivation. By this point, they also will likely have had exposure to a number of contextual cues for relations such as comparison and difference, at a non-arbitrary level (i.e. physical relations between stimuli such as bigger/smaller or same/different). Thus, they will likely be able to do non-arbitrary relational responding while not yet being able to show fully contextually controlled relational framing in which the relational response is independent of the physical properties of the actual stimuli being related.

In comparison relations, the bidirectional relations between stimuli are not symmetrical—for example, mutual entailment would be demonstrated by an individual who, after being taught that A is greater than B, responds that B is less than A. In this example, combinatorial entailment might be probed with the addition of a second trained relation such as "C is less than B", for example, and testing for the derivation of "A is greater than C" and "C is less than A". Rehfeldt (2011) points out the relevance of comparative relational responding to many early academic tasks such as telling time, measurement, and basic arithmetic. While each of these skill sets involve different content, they all involve basic relations of comparison between and among the stimuli; hence the same types of relational multiple exemplar training could be utilized for teaching all of them.

Y. Barnes-Holmes, D. Barnes-Holmes, Smeets, Strand, et al. (2004) were the first to demonstrate the training of arbitrarily applicable relational responding skills through MET when those skills were absent, and the specific type of relation involved was comparison. This study used abstract stimuli (paper "coins") and arbitrarily assigned values (being able to buy "more" or "less" sweets with different coins). Three children, ages 4 to 6, were taught specific relations among "coins", (e.g., $A > B > C$ or $A < B < C$), and were then asked which coin they would or would not bring to the shop to buy as many sweets as possible. For example, at the simplest (i.e. two stimulus level), two paper coins would be placed in front of the child from left to right (A-B), and the experimenter would say, “If this coin [pointing to coin A] buys more sweets than this coin [pointing to coin B], which would you bring to the shop to buy as many sweets as possible?” (A>B). Four trial types were presented for AB: A<B, A>B, B>A, B<A. For ABC relations, the coins were positioned from left to right (A-B-C) and an additional four trial types were presented: A<B<C, C<B<A, A>B>C, C>B>A. All participants failed to respond consistently in accordance with any of these relational tests. Training was then given in the same format, but with correction/reinforcement following incorrect/correct responding. Following extensive training with multiple sets of stimuli (and for one participant, additional training in non-arbitrary comparative relations), all participants were able to demonstrate generalized responding with more than/less than relations.

Berens and Hayes (2007) replicated and extended the previous study, addressing several potential weaknesses of that study, and providing a demonstration of the extent to which MET can result in relational responding within a frame of comparison. Whereas Y. Barnes-Holmes, D. Barnes-Holmes, and Smeets (2004) used relatively short baselines and trained all trial types (thus limiting the ability to determine whether skills generalized to new trial types or simply to novel stimulus sets), Berens and Hayes (2007) tested for generalization following each phase of training, used both linear and nonlinear trial types as described below, and provided for lengthier baselines. In linear combinatorial trial types, the relations trained are all in the same direction when the stimuli are lined up before the participant. For example, given an array of A-B-C, the experimenter might say, “This [pointing to A] is more than that [pointing to B], and this [pointing to B] is more than that [pointing to C]. Which one would you use to buy candy?” These tasks also involved the same trained relation (e.g., in the case of the latter example, both trained relations are ‘more’). Non-linear trial types are more complex both because they involve trained relations that are in two different directions and because the relations themselves are different (i.e., both “more” and “less” are trained). For example, given the array A-B-C, the experimenter might say, “This [pointing to A] is more than that [pointing to B], and this [pointing to C] is less than that [pointing to B]. Which one would you use to buy candy?” As in the previous study, participants were initially unable to respond with consistent accuracy, but following MET they were able to respond correctly across a range of task types. While improvements were greatest on the specific trial types trained, improvements also occurred on untrained trial types, providing additional evidence for relational responding within a frame of comparison as an operant.

This study was conducted with typically developing young children who were not able to demonstrate comparative relational responding. Of particular note for practitioners assessing and training relational responding skills for children with language delays, the study also identified potential prerequisites in the development of comparative relations. As was the case for one participant in the previous study, two participants who initially failed to demonstrate arbitrary comparative relations were also found to be unable to demonstrate non-arbitrary comparative relations (i.e. identifying which pile of pennies had “more or less”). Once trained in non-arbitrary comparative relations these participants were successfully trained in the arbitrary comparative relations. Gorham et al. (2009) subsequently replicated and extended this work to children with ASD as well as typically developing children.

In a variation on these studies establishing derived comparative responding, Murphy and D. Barnes-Holmes (2010) examined the development of derived manding via transformation of functions through a frame of comparison, with both typically developing children and children with ASD. In this study, a modification of the token game procedure previously described (Murphy et al., 2005) was used first to establish manding using stimulus cards (nonsense CVC words/text) for specific amounts (+2, +1, 0, -1, -2) of tokens (smiley faces), in order to correctly fill up the token board. Other stimuli (abstract shapes designated X and Y) were then established as contextual cues for “more” or “less” relational responding by teaching the selection of lines of either a greater or fewer number of smiley faces in the presence of each. Baseline conditional discriminations were then trained to establish comparative relations between a novel set of A/B/C/D/E stimuli (e.g., A>B, B>C, C>D, D>E), using the X/Y stimuli as contextual cues for selecting the appropriate stimulus (the one that is “more” or “less” than the other). Participants were then taught to mand for either +1 or -1 tokens to play the token game, and were subsequently tested for derived mands for +2 or -2 tokens. Five of the seven participants in this study could show transformation of function without training (and were able to demonstrate derived mands when the order of A-E stimuli was reorganized). For the two participants who were not able to immediately demonstrate transformation of functions, the functions were directly trained, by teaching the participants to mand with the appropriate stimuli. After MET with two sets of stimuli, these children were then able to demonstrate derived manding with a novel stimulus set.

Teaching the frame of opposition. In Y. Barnes-Holmes, D. Barnes-Holmes and Smeets (2004), typically developing 4 to 6 year old children were tested and then trained for the ability to respond in accordance with frames of opposition, again using a game in which arbitrary “coins” were assigned value. In this case, children were told that a particular coin bought “many” or “few” sweets, and then told that another coin was “opposite” to that coin, for a sequence of 4-10 coins (e.g., A=many, A is opposite B, B is opposite C, C is opposite D). The children were then asked which coin or coins they would or would not take to the shop to buy as many sweets as possible. All children initially failed tests of derived responding and were subsequently exposed to extensive MET on the specific relations. After training, all children were able to demonstrate generalized opposite responding (including with novel coin sets as well as other stimuli such as pasta shapes).

Pérez-González, García-Asenjo, Williams and Carnerero (2007) used MET to attempt to establish derived antonyms. In this study, two children with pervasive developmental disorder were first tested for their ability to reverse intraverbal opposite pairs (e.g., if taught to respond “cold” in answer to the question “What is the opposite of hot?” could they answer the question “What is the opposite of cold?”). Both children failed initial tests of this ability, but after specific training on the reversed relations with multiple sets of stimuli, both were able to demonstrate the reversed relations with novel stimulus sets. This can be seen as demonstrating derived symmetrical responding with antonyms. However, it is not clear that derived relational responding in a frame of opposition was demonstrated. At the level of mutual entailment, responding in accordance with opposite is symmetrical (if A is opposite B then B is opposite A) and is thus indistinguishable from sameness responding. It is not until combinatorial entailment is present (if A is opposite B and B is opposite C, then A and C are the same) that one could definitively identify this skill as relational responding within the frame of opposition. Moreover, in this study there was no test for the “meaning” of opposite relations, such as a test of transformation of function (e.g., as conducted in Y. Barnes-Holmes, D. Barnes-Holmes, and Smeets (2004), or even of non-arbitrary “oppositeness”. One useful test of non-arbitrary opposite relations, for example, might involve allowing a child to feel three glasses of water at different temperatures - one cold, one hot and one neutral - and then allowing her to touch a further glass that is either hot or cold and asking her to put it first with the same and then with the opposite. If a child cannot pass tests that tap into relevant functions such as these then it is unlikely that they are responding to "hot" and "cold" as opposite in a meaningful way. As Pérez-González et al. (2007) did not test for any such functions then, from an RFT perspective at least, their results cannot be seen as a clear demonstration of opposite relations.

Teaching deictic frames. Perspective-taking skills have been shown to be crucial to a variety of social and interpersonal interactions (e.g., Baron-Cohen, 2001; Baron-Cohen, 2005; Downs & Smith, 2004; Flavell, 2004; Klin, Schultz, & Cohen, 2000; Perner, 1988, 1991). Traditionally this area of research has been the preserve of cognitive psychologists who explain perspective taking as being based on *Theory of mind* ability. Theory of mind (ToM) is said to involve being able to infer the full range of mental states (beliefs, desires, intentions, imagination, emotions, etc.) that cause action. In brief, having a theory of mind is to be able to reflect on the contents of one's own and other's minds (Baron-Cohen, 2001, p. 174). ToM theorists generally believe that perspective-taking skills emerge around 5 years of age as a function of biological maturation (Baron-Cohen, 2005). However, from a current behavior analytic and more specifically RFT viewpoint, these skills are thought to emerge as a function of behavior-environment relations and as such can be targeted for intervention. For RFT, responding in accordance with perspective taking relations shares qualities of arbitrariness and generalization with other relations, but the interactions are more complex in the case of the former. RFT terms these *deictic* relational frames. Perspective taking involves three key types of relations: I versus you, here versus there, and now versus then. Responding in accordance with these relations is hypothesized to emerge in part through a history of responding to questions such as "What am I doing here?" or "What were you doing then?" Although the form of these questions is often identical across contexts, the physical environment is always different. What remain consistent are the relational properties of I versus you, here versus there, and now versus then. McHugh et al. (2004) developed a protocol to examine these relational abilities. Specifically, the protocol looks at the three perspective-taking frames (I-you; here-there; now-then) across three levels of complexity (Simple, Reversed, and Double-Reversed). For example, children have to respond relationally to correctly answer questions such as, "I have a red ball and you have a blue ball, what ball do you have? What ball do I have? (simplest type of relation). A more complex scenario would involve a reversal (i.e., "If I were you and you were me, which ball would I have? Which ball would you have?"). Double-Reversed relations combine reversals of two deictic relations (e.g., "I am sitting here on a blue chair and you are sitting there on the black chair. If I was you and you were me and if here was there and there was here, where would I be sitting? Where would YOU be sitting?"). There is evidence that ability to perform on these deictic relational responding tasks follows a similar developmental sequence to ability to perform on tests of Theory of Mind (McHugh, et al., 2004; McHugh, , Barnes-Holmes, Barnes-Holmes, Stewart, & Dymond, 2007; Rehfeldt et al., 2007; Weil et al., 2011), and also that deictic relational performance correlates with intellectual functioning as measured by standardized IQ tests (Gore, Barnes-Holmes & Murphy, 2010).

Rehfeldt et al. (2007) demonstrated that specific multiple-exemplar training on simple, reversed, and double reversed relations for I-you, here-there, and now-then established these relational operants for two typically developing children (ages 9 and 10) when they were not present in initial testing.

In a more recent study, Weil et al., (2011) replicated these findings in three younger children (57 to 68 months old). Using a shortened version of the perspective-taking protocol (McHugh et al., 2004) and using a multiple baseline design across persons and tasks, deictic relational frames were successfully trained. All three children showed clear increases in deictic framing that generalized across stimuli, suggesting the acquisition of an operant class. In addition, all of the children showed improvement on Theory of Mind tasks following improvements in deictic performance at the Reversed and Double-Reversed levels. This research, while only beginning, is particularly exciting as it indicates the possibility of teaching perspective taking to children with ASD, for whom it appears to be a key deficit.

Teaching Using an Existing Repertoire of Derived Relational Responding

We will next examine studies that have used participants' existing repertoire of derived relational responding to further other educational goals. That is, these studies have not employed MET to *establish* the ability to derive relations as such, when that skill is absent (as described above). Rather, they have employed relevant stimulus arrangements within match-to-sample procedures to train specific conditional discriminations and thereby capitalize on the derived responses that would be seen when an individual already has a repertoire of derived relational responding. In these studies, participants were (either immediately or after a limited amount of testing) able to respond accurately on tests of emergent relations (for example, by demonstrating stimulus equivalence, or by passing a test of combinatorial entailment within a frame of comparison), thus indicating that the relevant relational responding skills had already been acquired. A key feature of these studies is that they involve the training of a limited selection of relational responses (e.g. A-B and C-B), followed by testing for additional derived relations (e.g., A-C). Successful demonstrations illustrate the potential generative power of such training arrangements (which we will refer to as using an "equivalence training/testing procedure") for those with a suitable repertoire.

The studies described in this section represent that sample of the available literature that has focused on teaching educationally-relevant skills to individuals with ASD or other developmental delays (for reviews of studies that include other populations and/or are experimental rather than applied in nature, see May, Hawkins & Dymond, 2013; McLay, 2013; Rehfeldt, 2011). Skills targeted for improvement have included reading and spelling (e.g., De Rose, de Souza, & Hanna, 1996; Sidman, Cresson, & Willson-Morris, 1974); name-face matching (e.g., Cowley, Green, & Braunling-McMorrow, 1992); transitioning using activity schedules (Miguel et al., 2009; Sprinkle & Miguel, 2013); US geography (LeBlanc, Miguel, Cummings, Goldsmith & Carr, 2003); money skills (Keintz, Miguel, Kao & Finn, 2011; McDonagh, McIlvane & Stoddard, 1984); communication skills including manding using manual signs, picture exchange communication and vocal communication (e.g., Gatch & Osborne, 1989; Halvey & Rehfeldt 2005; Murphy & Barnes-Holmes, 2009a, 2009b; Rehfeldt & Root, 2005; Rosales & Rehfeldt 2007); and using metaphorical reasoning (Persicke et al., 2012).

Teaching skills using simple derived relational responding. The basic match-to-sample method used by Sidman (1971) has been employed in several studies to capitalize on the emergence of derived relations between pictures and text. De Rose et al. (1996) used this method to teach reading and spelling to typically developing children who were nonreaders and behind their peers. The students learned to match 51 printed words to the corresponding dictated words and to copy and name printed words with movable letters. All of the children showed the emergence of reading skills, and some also read generalization words at the conclusion of training. Similarly, Cowley et al. (1992) taught adults with brain injuries to conditionally relate their therapists' dictated names to their photographs and written names. Posttests showed the emergence of untrained conditional relations involving photos and written names, and 2 participants were capable of orally naming the photos. Sprinkle & Miguel (2013) and Miguel et al. (2009) evaluated whether an appropriate pattern of conditional discrimination training would serve to transfer the control from activity-schedule pictures to printed words (i.e., derived textual control). In these studies, preschoolers with ASD were taught to select pictures and printed words given their dictated names. Following training, participants could respond to printed words by completing the depicted task on an activity schedule, match printed words to pictures, and read printed words without explicit training (i.e., they showed emergent relations, including transfer of function). Sprinkle & Miguel (2013) further found that training of conditional discriminations using matching to sample protocols was superior to stimulus fading procedures for facilitating the demonstration of emergent relations.

Other academic skills have also been targeted using equivalence training/testing procedures. LeBlanc et al. (2003) taught US geography facts to two children with ASD, using a match-to-sample procedure. Both children were able to master the trained geography relations and emergent stimulus relations were also observed. Keintz et al., (2011) examined the applicability of stimulus equivalence to teaching money skills to children with ASD. The participants were taught three relations between coins, their names, and values. After the initial training, four relations emerged for the first participant and seven for the second, suggesting that this technology can be incorporated into educational curricula for teaching prerequisite money skills to children with ASD.

A number of recent studies have also extended functional communication by capitalizing on relational responding skills. Rehfeldt and Root (2005) examined whether training in specific conditional discriminations would result in derived manding skills in three adults with disabilities (in fact this was the first empirical demonstration of this phenomenon). Participants were first taught to mand for preferred items using pictures; they were then taught conditional discriminations between pictures and their dictated names and between dictated names and their corresponding text. Manding for preferred items using corresponding text was then evaluated and all three participants demonstrated derived manding. In another study, Halvey and Rehfeldt (2005) demonstrated derived vocal manding in three adults with severe developmental disabilities. Again, they evaluated whether a history of training in specific conditional discriminations would give rise to untrained vocal manding for novel items. Participants were first taught to mand for preferred items using their category names. They were then taught conditional discriminations between pictures of preferred items that were categorically related. Finally, they were tested for their ability to mand for items that had not been originally presented during mand training, using their category names. All participants demonstrated untrained manding, and for some of them, changes in the mand repertoire were accompanied by changes in the tact repertoire. Some participants also showed generalization of skills across settings.

Murphy and Barnes-Holmes (2009a) also established more complex derived manding with individuals with ASD, showing the transfer of functions of "more" and "less" in a token game (similar to that described previously). Participants were first taught to mand for either "more" or "less" tokens using arbitrary symbols (A1 and A2). Following training in the relevant conditional discriminations (A-B and C-B), participants were then able to mand for either "more" or "less" tokens using the newly-related symbols (C1 and C2).

Extending this research further, Murphy and Barnes-Holmes (2009b) taught specific mands for +2, +1, 0, -1, and -2 tokens (A1, A2, A3, A4, and A5) in a similar game. Following training in the relevant baseline conditional discriminations (A-B and B-C), participants then demonstrated derived manding using the newly related symbols (C1, C2, C3, C4, and C5).

The vast majority of studies teaching educationally-relevant skills using existing derived relational responding skills have utilized participants' skills within a frame of coordination or stimulus equivalence. As described previously, though, RFT proposes numerous other relational frames, and existing skills in any frame could potentially be used to teach other skills more efficiently. For example, in Murphy and Barnes-Holmes (2010), responding within a frame of comparison was established, and five of the seven participants then demonstrated derived manding via transformation of functions within the frame of comparison, in the context of the token game.

Teaching skills using complex derived relational responding. One particularly interesting and potentially useful example of a relational framing skill is that of relating relations themselves, which is the basis of analogical and metaphorical reasoning. Like perspective-taking, analogical reasoning is a complex verbal repertoire and has traditionally been investigated from a cognitive perspective. In this view, deficits in metaphorical language seen in children with ASD and other developmental delay are thought to be caused by dysfunction in underlying neurolinguistic mechanisms (e.g., Baron-Cohen, 2001; Gold & Faust, 2010). Relational frame theorists (e.g., Barnes, Hegarty & Smeets, 1997; Stewart & Barnes-Homes, 2001a, 2001b) have provided an interpretation of this repertoire based on relating derived relations in the context of a variety of different types of relations. In a classic analogy test, two different stimulus sets should be related if they each show the same type of relation—e.g., apple is to fruit as cat is to mammal (each set demonstrating a hierarchical relation), nickel is to dime as apartment is to mansion (each set demonstrating a comparison relation), etc. As such, analogy has been examined by behavior analysts as the relating of derived (and typically equivalence) relations. For example, in the first published study of this effect, Barnes et al., (1997) first trained and tested participants for equivalence relations amongst arbitrary stimuli and subsequently showed that they would also relate pairs of stimuli in equivalence relations to each other and pairs of stimuli in non-equivalence relations to each other. For instance, after first deriving the equivalence relations A1-B1-C1, A2-B2-C2, A3-B3-C3 and A4-B4-C4, participants subsequently matched B1-C1 (equivalent) to B3-C3 (equivalent) rather than B3-C4 (non-equivalent), and matched B1-C2 (non-equivalent) to B3C4 (non-equivalent) rather than B4C4 (equivalent).

Barnes et al. (1997) and the other studies just cited generally used adults or older children to show the equivalence-equivalence effect. However, in more recent studies of greater relevance to the current review, Carpentier, Smeets and Barnes-Holmes (2002, 2003) tested relatively young developmentally typical (5 year old) children and showed both that they were not able to consistently demonstrate equivalence-equivalence relations (in contrast with 9 year olds and adults, thus indicating a developmental pattern similar to that shown in classic analogy research) as well as that with suitable training they could be supported in the derivation of these relations. Carpentier et al. suggest that the learning of this ability happens to a significant extent based on training that children receive in typical academic environments. Their research points in important directions as regards the testing and training of this potentially important repertoire in both typically developing and developmentally delayed populations.

From an RFT point of view, metaphor is similar to analogy in that it also involves deriving relations of sameness between relational networks. In addition, in metaphor, a key part of the process is identification of a property shared between the two related domains which supports the derivation of relational similarity. In a recent study, Persicke et al. (2012) evaluated multiple exemplar training for teaching children to attend to relevant features of the context in which a metaphor was used and to engage in the required relational responding in order to respond correctly to metaphorical questions. In this case, the component relational responding skills (coordination, distinction, and hierarchy) were already established, but, in accordance with an RFT approach, the children were taught using MET to use these existing skills in combination. Three children, aged 5–7 years with a diagnosis of ASD participated. For each trial the experimenter read a story (e.g., "One of my co-workers brought a cake to work last week. The cake had fluffy frosting, and it smelled really good, but the cake was really hard on the inside") and asked questions based on a metaphor (e.g., "If I say the cake was perfume, what do I mean?") that required the identification of the property in common between the target and vehicle (e.g., smelling good). While the specific content of the stories and metaphors changed across trials the relations targeted remained constant and the results suggested that MET was effective for remediating deficits in metaphorical reasoning. All participants demonstrated generalization of this ability to multiple untrained metaphors and it was anecdotally reported that some children started to create their own metaphors across the intervention (i.e., expressive untrained metaphorical language skills were also emerging). The potential to teach such a flexible, generally applicable skill, as opposed to teaching a child to memorize particular content (i.e., learning metaphors rotely) strongly indicates the merits of targeting skills using an RFT analysis when designing language interventions for children with ASD or developmental delay more broadly.

Conclusions and Future Directions

As outlined above, there is now a small but growing body of evidence both for using existing derived relational responding skills to quickly and efficiently teach new concepts and generate more varied responding (such as novel mands), and also for training derived relational responding skills when they are absent. As stated initially, we propose that RFT offers both clear empirical evidence as well as a clear conceptual pathway for identifying both priorities for skills to teach (i.e., flexible derived relational responding skills across a variety of relational frames) as well as procedures for teaching such skills. Regardless of the differences in theoretical orientations and debate within the field about underlying processes, all the studies reviewed here have in common the fact that they point to environmental histories/manipulations that result in "generative" verbal behavior. The implications for teaching language to individuals with ASD or developmental disabilities (as well as providing suggestions for more efficient and effective educational strategies in general) are significant.

First, if a student can demonstrate derived relational responding of a particular type (e.g. equivalence, naming, comparison), then those skills may be used to more efficiently program lessons for learning new vocabulary and academic skills, and for rapidly expanding functional communication skills. Moreover, knowing that a student is able to demonstrate particular relational skills is one indicator of when to stop specifically targeting particular skills—for example, if a student is able to demonstrate equivalence, it is likely not necessary to continue targeting specific nouns, verbs, and so on for teaching both as a listener discrimination and as a tact. We would argue that derived relational skills such as this are a more critical progress marker than simply the quantity of listener discriminations or tacts that a student has learned.

Second, if a student cannot demonstrate particular derived relational responding skills (whether naming, equivalence, or more advanced relational frames), then we argue that curricular programming should focus on establishing those skills through multiple exemplar training of the relevant pattern of responding. Luciano et al. (2009) make a number of suggestions for training early relational operants based on RFT. Some of the research studies that have been discussed in this article also give some indications of important teaching and curricular sequencing principles, as follows: (1) multiple exemplar training in bidirectional stimulus relations would appear to be critically important for establishing mutual entailment (Luciano et al., 2007; Pérez-González et al., 2007) and naming (Greer & Ross, 2008); (2) multiple exemplar training can also be used to facilitate the emergence of combinatorially entailed derived relational responding in a number of frames (Barnes-Holmes, Y., Barnes-Holmes, D., Smeets, Strand et al., 2004; Barnes-Holmes, Y., Barnes-Holmes, D., & Smeets, 2004; Berens & Hayes, 2007; Gorham et al., 2009); (3) training transfer of mand functions may be an efficient as well as functionally important method of facilitating the emergence of equivalence as well as other frames (Murphy et al., 2005; Murphy & Barnes-Holmes, 2010); (4) ensuring fluent non-arbitrary relational responding within a particular frame is almost certainly necessary prior to attempting to teach arbitrary relational responding (Barnes-Holmes et al., 2004; Berens & Hayes, 2007; Gorham et al., 2009); (5) perspective-taking—a critical deficit for children with ASD—may be facilitated through the use of procedures for training deictic relational framing (McHugh et al., 2004; Rehfeldt et al., 2007; Weil et al., 2011); (6) multiple exemplar training that targets a number of arbitrary relational frames can effectively establish flexible, generally applicable skills in metaphorical reasoning that have previously been shown to be deficient (Persicke et al., 2012).

Finally, in order to implement the above recommendations, it is first necessary to assess a student's current derived relational responding ability, as this will inform the development of goals and curricula. This is not as yet a typical component of assessment in intervention programs for children with ASD (although some assessment tools such as the Verbal Behavior Milestones Assessment and Placement Program [Sundberg, 2008] do reference the emergence of novel behavior as a progress marker), and we argue that it should be. A critical area for future research is the development of a standardized tool for the systematic assessment of relational responding abilities and their precursor skills. One such tool, the Training and Assessment of Relational Precursors and Abilities (TARPA; Moran, Stewart, McElwee & Ming, 2010; Moran, Stewart, McElwee & Ming, 2014) is currently being developed for the assessment of precursor and early relational responding abilities. The TARPA is a computer based protocol that assesses a number of key forms of responding that are critical (from a derived relational responding perspective) to the development of generative behavior, including basic discrimination, non-arbitrary conditional discrimination, arbitrary conditional discrimination, mutually entailed relational responding, combinatorially entailed relational responding and transformation of function. In addition, sections are further divided into tracks based on the modality of the stimuli involved (e.g., visual only, auditory only or a combination of both visual and auditory stimuli). Thus, the TARPA provides a comprehensive assessment of the prerequisite skills to relational responding as well as assessment of relational responding abilities at the level of equivalence.

Rehfeldt (2011) highlighted the relative dearth of research looking at relational responding with respect to auditory stimuli and considered this noteworthy given how fundamental the formation of auditory-visual stimulus relations is for understanding spoken language. The TARPA, which is designed to assess relational responding across modalities, could be an important basic and applied tool in the future study of this particular area. In addition, the same sequence of testing inherent in the TARPA could be carried out in table-top formats in order to assess topographical responding (e.g., spoken words, signs, written responses, spelling) rather than selection-based responding, and further research in this area is clearly needed. A move away from the match-to-sample formats frequently used in research into relational responding may be necessary in order to develop a better applied technology, as the verbal community more often requires topography-based responding rather than selection-based (Rehfeldt, 2011). In addition, the TARPA is currently being developed to allow assessment and training of frames other than equivalence (e.g., distinction, opposition, comparison) which will also advance research in this area. Indeed, Rehfeldt (2011) outlined the need for researchers to look beyond equivalence responding if the derived stimulus relations paradigm is to have any utility in teaching more complex skills. The research presented in this paper would suggest that behavior analysis is primed for this and that in fact it is already happening (e.g., Gorham et al., 2009; Murphy & Barnes-Holmes, 2010).

There is clearly much research to be done to determine the most effective and efficient means of establishing derived relational responding skills, the sequencing of the component skills necessary for derived relational responding, and the sequencing of different relational frames. In addition, Rehfeldt (2011) outlined recommendations for future research into the transportability, generalization and maintenance of relational responding interventions. Nonetheless, what has been accomplished so far provides important additional direction for behaviorally-based programs for individuals with autism and other language delays. Traditionally, we have measured progress through the acquisition of content—for example, numbers of tacts and mands, or the number of nouns, verbs, and prepositions, and so on. However, working from the perspective of the derived relational responding literature, targeting a small number of processes (bidirectional or mutually entailed responding, combinatorially entailed responding, transformation of function) within different patterns of derived relational responding (same, different, comparison and so on) allows complex verbal behavior to be established systematically and efficiently, and allows for progress to be systematically assessed not just in terms of content, but also in terms of critical language learning processes. Undoubtedly this is an exciting prospect for behavioral intervention.

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